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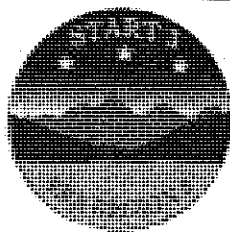
United States  
Environmental Protection Agency  
Contract No. EP-W-05-050

## ANALYTICAL RESULTS REPORT for SITE REASSESSMENT

UPPER ANIMAS MINING DISTRICT  
Silverton, San Juan County, Colorado

TDD No. 1008-13

AUGUST 10, 2011



## URS

OPERATING SERVICES, INC.

In association with:

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**ANALYTICAL RESULTS REPORT  
For  
SITE REASSESSMENT**

**UPPER ANIMAS MINING DISTRICT  
Silverton, San Juan County, Colorado**

**CERCLIS ID# CO0001411347**

**EPA Contract No. EP-W-05-050  
TDD No. 1008-13**

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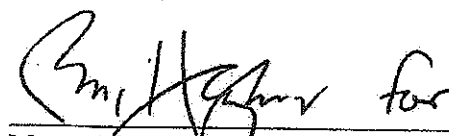
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August 10, 2011

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## ANALYTICAL RESULTS REPORT for SITE REASSESSMENT

UPPER ANIMAS MINING DISTRICT  
 Silverton, San Juan County, Colorado

CERCLIS ID# CO0001411347

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## 1.0 INTRODUCTION

This Analytical Results Report (ARR) for the Upper Animas Mining District Site Reassessment (SR) in Silverton, San Juan County, Colorado, has been prepared to satisfy the requirements of Technical Direction Document (TDD) No. 1008-13 issued to URS Operating Services, Inc. (UOS) under the U.S. Environmental Protection Agency (EPA) Region 8 Superfund Technical Assessment and Response Team 3 (START) Contract No. EP-W-05-050. This report has been prepared in accordance with the EPA "Guidance for Performing Site Inspections under CERCLA," Interim Final, September 1992, and the "Region 8 Supplement to Guidance for Performing Site Inspections under CERCLA" (EPA 1992, 1993). Field work at the Upper Animas Mining District site included a site reconnaissance in September 2010 and sampling activities which were conducted between October 25 and November 1, 2010. Site activities followed the Site Inspection (SI) format and the Generic Quality Assurance Project Plan and the applicable UOS Technical Standard Operating Procedures (TSOPs) (UOS 2005a, b).

The field activities conducted by UOS specifically included the collection of 54 surface water samples, 54 co-located sediment samples, and 14 source soil samples; these sample numbers include three surface water duplicate samples and three sediment field replicate samples collected as field Quality Assurance/Quality Control (QA/QC) samples (in addition to the three laboratory matrix spike/matrix spike duplicate [MS/MSD]) which did not count as additional samples (Table 1).

The soil and sediment samples were shipped under custody via FedEx to a Contract Laboratory Program (CLP), Routine Analytical Services (RAS) laboratory, ALS Laboratory Group in Salt Lake City, Utah. Soil and sediment samples were analyzed for Target Analyte List (TAL) metals and polychlorinated biphenyls (PCBs). Surface water samples were hand-delivered under custody to the EPA Region 8 Environmental Services Assistance Team (ESAT) Laboratory in Golden, Colorado. All surface water samples and aqueous source samples designated for dissolved TAL metals analysis were filtered in the field at the time of sample collection. Aqueous source samples (adit discharges) were also analyzed for unfiltered total TAL metals (see section 5.2.1 for further detail).

All analytical results were validated. Soil and sediment data was validated by Fred Luck and surface water and adit discharge samples were validated by Diane Short & Associates. No significant data quality issues were identified and the validation reports are presented under separate cover in Appendix B.

This ARR is intended to be used in conjunction with the Upper Animas Mining District Field Sampling Plan (FSP) that was approved by EPA on October 21, 2010, and the Upper Animas Mining District Trip Report presented in this report under separate cover as Appendix A (UOS 2010, 2011a).

## 2.0 OBJECTIVES

Previous investigations in the Upper Animas Mining District identified the tailings piles and adit discharges as sources of contamination, but did not yield conclusive information regarding possible migration of contaminants into the Groundwater, Surface Water, and the Soil Exposure Pathways. This SR was performed to determine if any contamination from the identified sources in Upper Cement Creek drainage in the Upper Animas Mining District area has migrated into the environment where it is impacting environmental and/or human health targets. The purpose of this SR was to gather information for the evaluation of this site with regard to the EPA's Hazard Ranking System (HRS) criteria (Office of the Federal Register [OFR] 1990). The specific objectives of this SR were:

- Document and evaluate source areas; including waste volumes;
- Document overland flow of water to Cement Creek;
- Evaluate targets for the groundwater, surface water, soil, and air pathways;
- Evaluate non-sampling data documenting past observed releases from site source areas;
- Collect surface water samples to document a release to Cement Creek and the Animas River;
- Collect sediment samples to document a release to Cement Creek and the Animas River;
- Document target locations for fisheries and wetlands;
- Document fisheries use;
- Collect soil (source) samples to characterize potential contaminants at the site and characterize the extent of surface soil contamination that may affect overland water flow to Cement Creek; and
- Collect soil samples to characterize potential contaminants at the site and characterize the extent of surface soil contamination that may affect the nearby residents, Silverton Mountain workers, all-terrain vehicle (ATV) riders and other recreationalists.

## 3.0 SITE DESCRIPTION

Cement Creek originates high in the rugged San Juan Mountains of southwestern Colorado near the San Juan County and Ouray County line on the south slopes of Red Mountain Number 3 and the north slopes of Storm Peak. Cement Creek begins at an elevation of 13,000 feet above mean sea level (MSL) and



flows 7 miles southward to an elevation of 9,305 feet above MSL at its confluence with the Animas River at Silverton, Colorado (Figures 1 and 2) (Colorado Department of Public Health and Environment [CDPHE] 1998). The name Cement Creek probably refers to the iron rich precipitates (ferricrete) that coat and cement the stream bed materials (U. S. Geological Survey [USGS] 2007e). This investigation focused on the largest sources of unremediated mine waste and mine discharges in Upper Cement Creek (above Gladstone) including the American Tunnel (Appendix A, photos 27, 28, and 47), Gold King 7 Level Mine (Appendix A, photos 38 and 74), Red and Bonita Mine (Appendix A, photos 35, and 48-51), Mogul Mine (Appendix A, photos 46, 63, and 68-70), Mogul North Mine (also known as the Mogul Sublevel 1), and Grand Mogul Mine (Appendix A, photos 58-60 and 63-67). These mines and discharges will henceforth be referred to as the "upper Cement Creek mines" or "upper Cement Creek discharges." The Queen Anne Mine, the Columbia Mine, and the Adelphin Mine are also potential sources in the area, but could not be addressed at the time of this investigation because they were inaccessible due to snow cover (Appendix A, photos 37, 56, and 57). This investigation also addressed potential PCB contamination in the sources and sediments of Cement Creek and the Animas River.

### 3.1 SITE HISTORY

The rugged and relatively inaccessible western San Juan Mountains were first prospected by the Baker party, which explored the area around Silverton in 1860. After a treaty with the Ute Indians was revised, mining began in 1874, and George Green brought the first smelter equipment into the area at Baker's Park that year (Silverton Magazine 2009). The extension of the railroad from Silverton up Cement Creek to Gladstone in 1899 encouraged the mining of low grade ores, and the establishment of a lead-zinc flotation plant in 1917 allowed for the treatment of the low grade complex ores found in the area (USGS 1969). The last producing mine in the area was the Sunnyside Mine, which ceased production in 1991 (USGS 2007c). The closing of the Sunnyside mine occurred after Lake Emma drained into the mine and out the American Tunnel into Cement Creek in 1978. The flood water from the Lake Emma "blow-out" was reported to have flowed down Cement Creek in a 10-foot wall of water that would have transported a large quantity of tailings and other mine waste down Cement Creek to the Animas River (The Silverton Railroads 2009).

Over a 100-year period between 1890 and 1991, mining activities in the Upper Animas River Basin, including Cement Creek, produced the waste rock and mill tailings sources from which contamination spread throughout the Surface Water Pathway. Over 18 million tons of ore were mined from the Upper Animas River Basin area, with more than 95 percent of this being dumped

directly into the Animas River and its tributaries in the form of mill waste. Older waste rock piles and stope fillings were reworked and sent to mills as technology allowed lower grade ores to be economically processed. A great deal of abandoned waste was also milled during World War II when many older mining and milling structures were cannibalized for scrap metal. The history of mining and milling in the Cement Creek area can be divided into four eras, each of which produced different types and volumes of mine wastes.

- Phase 1 The Smelting Era (1871-1889). Mines were usually small, mining was done by hand, milling was rarely done, and small amounts of often highly mineralized rock were left in surface dumps. Zinc minerals were preferentially removed from the ore and left in mine dumps because zinc created problems during the smelting process. Total production of the entire Upper Animas River area during this era is estimated to be 93,527 short tons. Very little mine or mill tailings were directly discharged into the area streams (USGS 2007c).
- Phase 2 The Gravity Milling Era (1890-1913). Federal government support coupled with the introduction of higher capacity mining and milling techniques encouraged the mining of lower grade ores. Milling became the predominant ore processing method as ore values dropped and tonnage increased. Large volumes of mine and milling wastes were discharged directly into streams. Gravity mills recovered as much as 80 percent of the metals; however, zinc, iron pyrite, and some copper compounds were not recoverable, and when discharged into the streams, were easily spread downstream throughout the environment. Between 1890 and 1913 the total production of the entire Upper Animas River area was estimated at 4.3 million short tons (USGS 2007c). Approximately 95 percent of the waste generated during this era was discharged directly into the area streams (USGS 2007c).
- Phase 3 The Early Flotation Era (1914-1935). The increased demand for metals caused by World War I further accelerated the trend to larger scale mining and milling in the area. Ball mill grinding and froth flotation for concentrating ores were introduced, and again most mill tailings were dumped directly into area streams. During this era total production of the entire Upper Animas River area was estimated at 4.2 million short tons, of

which only 36,232 short tons were shipped out of the area to be smelted (USGS 2007c).

- Phase 4 The Modern Flotation Era (1936-1991). Mining almost came to a halt during the Great Depression, but mining activity resumed during World War II when many mines and mills were reopened with substantial support from the federal government. In addition to the newly mined material, waste rock from abandoned mines, in both the waste dumps and the old underground stope fills, was reclaimed and processed. Mining and milling processes improved in detail, but still used familiar technology. The major change was the impoundment of mill tailings that began as a result of a 1935 Colorado Supreme Court ruling that required operations to contain mill tailings. Some early attempts to contain mill tailings were not completely successful and resulted in catastrophic releases of mill tailings to area streams. Mining and milling in the Upper Animas River area had substantially decreased by 1953, and all mining and milling activity ceased in 1991. During this era total production of the entire Upper Animas River area was estimated at 9.5 million short tons. All mill tailings were impounded in settling ponds except for an estimated 200,000 short tons of mill tailings that were released into the Animas River area streams. Ore shipments to smelters totaled only 8,148 tons out of the 9.5 million short tons of production during this final era (USGS 2007c).

Reclamation activities have been ongoing in the Cement Creek basin since 1991 when tailings were removed from the Lead Carbonate Mill site. Reclamation work has also been conducted in Gladstone at the American Tunnel waste dump and portal, Herbert Placer settling ponds, and the Gold King 7 Level Mine. Downstream of Gladstone on Prospect Gulch, several mine sites have been remediated, including the Galena Queen Mine, Hercules Mine, Henrietta Mine, and most recently at the Joe and John Mine and the Lark Mine in 2006 and 2007 (Animas River Stakeholders Group [ARSG] 2007). No new reclamation activities were initiated in 2008 or 2009, but in 2010 the EPA initiated a removal assessment at the Red and Bonita Mine. EPA and the Bureau of Land Management (BLM)/U.S. Department of Agriculture (USDA)-Forest Service are also investigating the viability of removal assessments at the Grand Mogul Mine, which consists of both privately and federally-managed parcels.

## 3.2 SITE CHARACTERISTICS

### 3.2.1 Physical Geography

The Cement Creek drainage of the Upper Animas Mining District site is located north of the Town of Silverton, Colorado and is located on a combination of public and private property. The site is located in mountainous terrain and the elevation of the Cement Creek drainage ranges from 9,305 to 13,000 feet above MSL (USGS 1955).

### 3.2.2 Geology

The Cement Creek basin is located in the volcanic terrain of the San Juan Mountains. The area was a late Oligocene volcanic center where the eruption of many cubic miles of lava and volcanic tuffs covered the area to a depth of more than a mile (USGS 1969). The formation of the 10-mile diameter Silverton caldera produced faults that are generally concentric circular features. The caldera collapse was followed by multiple episodes of hydrothermal activity that produced widespread alteration and mineralization of the rocks (USGS 2007a). Cement Creek flows through the middle of the old Silverton caldera (EPA 1999).

The predominant rock type found in the Cement Creek Basin is the Oligocene Age Silverton Volcanics. The Silverton Volcanics are lava flows of intermediate to silicic composition and related volcanoclastic sediments that accumulated to a thickness of approximately 1,000 feet around older volcanoes prior to the subsidence of the Silverton Caldera (USGS 2002).

The regional propylitization of the rocks in the area prior to the collapse of the calderas created an altered regional rock type that contains significant amounts of calcite ( $\text{CaCO}_3$ ), epidote ( $\text{Ca}_2\text{Fe}(\text{Al}_2\text{O})(\text{OH})(\text{Si}_2\text{O}_7)(\text{SiO}_4)$ ), and chlorite ( $(\text{MgFeAl})_6(\text{SiAl})_4\text{O}_{10}(\text{OH})_8$ ), all of which contribute to the intrinsic acid-neutralizing capacity of the major regional rock type. Three major areas of post-caldera collapse mineralization and alteration have been identified in the Cement Creek drainage. The Ohio Peak-Anvil Mountain (OPAM) area on the west side of the lower Cement Creek drainage and the Red Mountains area on the northwest side of the upper Cement Creek drainage are both sites of 23-million-year-old acid-sulfate mineralization. The Eureka Graben area on the upper northeast side of the Cement Creek drainage is the site of 10- to 18-million-year-old emplacement of

northeast-trending polymetallic veins of silver, lead, zinc, copper, and often gold that formed as fracture or fissure filling material (USGS 2007d).

The Red Mountain and OPAM acid-sulfate hydrothermal systems cover 22 square kilometers and 21 square kilometers, respectively, along the margin of the collapsed Silverton Caldera on the west and northwest side of the Cement Creek Drainage (Figure 2). Most of the mineralization and mining activity in these two areas has occurred in the Red Mountain area with mines and adits related to the Red Mountain acid-sulfate system found in Prospect, Dry, Georgia, and Corkscrew Gulches, all tributaries of Cement Creek. The ores from these mines commonly contain enargite ( $\text{Cu}_3\text{AsS}_4$ ), galena ( $\text{PbS}$ ), chalcocite ( $\text{Cu}_2\text{S}$ ), tetrahedrite ( $(\text{Cu,Fe})_{12}(\text{Sb,As})_4\text{S}_{13}$ ), stromeryite ( $\text{AgCuS}$ ), bornite ( $\text{Cu}_5\text{FeS}_4$ ), chalcopyrite ( $\text{CuFeS}_2$ ), and pyrite ( $\text{FeS}_2$ ) along with elemental arsenic (As), copper (Cu), lead (Pb), and iron (Fe) (USGS 2007d).

Mineralization in the veins of the Eureka Graben area that is drained by upper Cement Creek include massive pyrite and milky quartz ( $\text{FeS}_2\text{---SiO}_2$ ), chalcopyrite ( $\text{CuFeS}_2$ ), galena ( $\text{PbS}$ ), sphalerite ( $\text{ZnS}$ ), fluorite ( $\text{CaF}_2$ ), and elemental gold (Au) and silver (Ag) (USGS 2007d).

The San Juan Mountains were nearly covered by alpine glaciers during the latest Pleistocene Pinedale glaciation. The thickness of glacial ice is estimated to have ranged from approximately 1,400 feet thick at Gladstone to 1,700 feet thick at Silverton. The Pinedale glaciation ended approximately 12,000 years ago and, except for the glacial till deposits, all surface sediments along Cement Creek were likely deposited after that time (USGS 2007e). Recent human activities have had relatively little influence on the overall shape and physical processes of Cement Creek (USGS 2007e).

### 3.2.3 Hydrogeology

Approximately 6,000 years ago, Cement Creek cut into the creek bed sediments by as much as 16 feet, causing a drop in the valley bottom shallow water table aquifer. Beginning about A.D. 400, Cement Creek aggraded the stream bed by as much as 10 feet, then between A.D. 1300 and A.D. 1700, Cement Creek cut back to the previous level established approximately 6,000 years ago. These changes in the shallow water table

elevations in the valley caused mineralization and cementation of the sediments in the stream course (USGS 2007e).

Groundwater in the Cement Creek area is found in cracks and fissures in the near surface of the igneous rocks that comprise the majority of the area (USGS 2007e).

#### **3.2.4 Hydrology**

The drainage area of Cement Creek is 20.1 square miles (USGS 2007b). Cement Creek flows through the middle of the old caldera, with the period of high flow being May, June, and July in response to snowmelt in the San Juan Mountains, and the periods of low flow occurring in later winter and late summer (EPA 1999). The average flow measured by the USGS on Cement Creek at Silverton before the confluence with the Animas River at station number 09358550 (also known as CC48) between 1992 and 2008 (excluding 1994) was 38.3 cubic feet per second (cfs). The highest average flow on Cement Creek was 56.3 cfs during 1995 and the lowest was 17 cfs during the drought of 2002 (USGS 2009). The drainage area of the Animas River is 146 square miles (USGS 2007b). The average flow measured by the USGS on the Animas River below Silverton at station number 09359020 (also known as A72) between 1992 and 2008 was 281 cfs (USGS 2009).

#### **3.2.5 Meteorology**

The Upper Animas River Basin and Cement Creek are located in an alpine climate zone. The average annual precipitation in the area is about 40 inches (National Oceanic and Atmospheric Administration [NOAA] 1973). Winter snowfall is heavy, and severe rain storms occur in the summer (USGS 1969). The average total precipitation for Silverton, Colorado as totaled from the Western Regional Climate Center database is 24.50 inches. The 2-year, 24-hour rainfall event for this area is 2 inches (NOAA 1973).

### **3.3 PREVIOUS INVESTIGATIONS**

- March 1995      *Reconnaissance Feasibility Investigation Report of the Upper Animas River Basin.* Colorado Division of Minerals and Geology. J. Herron, B. Stover, P. Krabacher, and D. Bucknam.

- October 1995 *Animas Discovery Report – Upper Animas River Basin.* CDPHE – Hazardous Materials and Waste Management Division. Camille Farrell.
- February 1997 *Water Quality and Sources of Metal Loading to the Upper Animas River Basin.* CDPHE – Water Quality Control Division. J. Robert Owen.
- July 1997 *Sampling and Analysis Plan for a Site Inspection of the Upper Animas Watershed, Silverton Mining District, San Juan County, Colorado.* CDPHE – Hazardous Materials and Waste Management Division. Camille Farrell.
- April 1998 *Analytical Results Report, Cement Creek Watershed, San Juan County, Colorado.* CDPHE Hazardous Materials and Waste Management Division. Camille Farrell. Five ground water, 6 surface water, 53 sediment, and 15 source samples collected in 1996. Data validation reports are not available. These data are not usable for a HRS evaluation of the site because sample locations are not documented and data validation cannot be documented.
- September 1998 *Cement Creek Reclamation Feasibility Report, Upper Animas River Basin.* Colorado Division of Minerals and Geology. Jim Herron, Bruce Stover, and Paul Krabacher. Forty waste rock locations and four soil locations in the Cement Creek drainage were sampled by collecting a liquid extract of the rock or soil material from 10 to 20 aliquots at each location. These data are not usable for a HRS evaluation of the site because the analytical results are for extracts from composite samples.
- March 1999 *Site Inspection Analytical Results Report for the Upper Animas Watershed, San Juan County, Colorado.* CDPHE – Hazardous Materials and Waste Management Division. Camille Farrell. Samples of mine waste rock, seeps, surface water, and sediment collected in 1997. Exact locations of samples were not documented. Photographs of sample locations are available. Data validation reports are not available. These data are not usable for an HRS

evaluation of the site because sample locations are not documented and data validation cannot be documented.

- May 2009 *Routine Water Quality Sampling, EPA Region 8 Laboratory.* On a monthly basis from May 2009 until the present, EPA personnel have conducted sampling activities at select locations in the Animas River, Cement Creek, and Cement Creek tributaries. At each location EPA personnel collected field data and samples for cations, anions, acidity, total dissolved solids (TDS), total suspended solids (TSS), and total and dissolved metals. Data has been published into a SCRIBE database and in summary spreadsheets made available to the ARSG.
- October 2009 *Data Gap Analysis Report for Targeted National Priority Listing Viability. Upper Animas Mining District.* URS Operating Services. Evaluation of the Cement Creek drainage using criteria of the Hazard Ranking System.

#### 4.0 DATA QUALITY OBJECTIVES FOR SAMPLING

The EPA Data Quality Objectives (DQO) Process is a seven-step systematic planning approach to develop acceptance or performance criteria for EPA-funded projects. The seven steps of the DQO process are:

- Step 1 The Problem Statement;
- Step 2 Identifying the Decision;
- Step 3 Identifying the Decision Inputs;
- Step 4 Defining the Study Boundaries;
- Step 5 Developing a Decision Rule;
- Step 6 Defining Tolerance Limits on Decision Errors; and
- Step 7 Optimizing the Sample Design.

These DQOs were developed by UOS based on information provided by the TDD and the EPA "Guidance for the Data Quality Objectives Process" (EPA 2000). The Upper Animas Mining District Site Reassessment Project Data Quality Objectives are presented under separate cover in this report in Appendix D.



Based upon the risks associated with the hazardous substances, the project team identified surface water pathway as the primary pathway of concern and soil exposure pathway as the pathways of secondary potential concern at the Upper Animas Mining District site during the September 2010 reconnaissance and the October and November 2010 sampling activities.

## **5.0 FIELD PROCEDURES**

### **5.1 SAMPLE LOCATIONS**

This SR involved the collection of 116 field samples and 6 field QC/QA samples (Figures 3, 4, and 5). These samples included 46 surface water samples, 46 sediment samples, 14 source soil samples, 5 adit water (aqueous source) samples, and 5 adit sediment samples. Additional QA/QC samples included three duplicate surface water samples and three duplicate sediment samples.

#### **5.1.1 Sample Identification**

Sample identification followed the following format:

- UA (Matrix ID) (Sample Location)

UA stands for Upper Animas Mining District Site. Matrices were identified as follows:

- SE = sediment
- SW = surface water
- SO = soil (waste pile/ source samples)
- AD = adit discharge

Sample locations were then numbered sequentially. Detailed information about the sample nomenclature is in the approved FSP (UOS 2010).

#### **5.1.2 Surface Water Samples**

Forty-two surface water samples plus three surface water duplicate samples were collected. Surface water samples were collected at points on the Animas River, Cement Creek, and Cement Creek tributaries. Figure 4 shows surface water sample locations.

### **5.1.3 Sediment Samples**

Forty-two sediment samples plus three sediment duplicate samples were collected. Sediment samples were co-located with surface water samples, which were collected at points on the Animas River, Cement Creek, and Cement Creek tributaries. Figure 4 shows the co-located surface water sample locations. Sediment sample location UASE010 was duplicated and named UASE060 because START was concerned there was not enough sample volume. Sample volume was determined to be appropriate by the laboratory, so sample UASE060 was not used in the data evaluation.

### **5.1.4 Source Samples**

#### **Soil Source Samples**

Fourteen of 25 planned source soil samples were collected. Samples UASO01 and UASO02 were collected in the vicinity of the American Tunnel. Samples UASO03, UASO04, and UASO05 were collected at the Red and Bonita Mine waste piles. Sample UASO06 was collected at the Mogul North Mine waste pile. Samples UASO07 and UASO08 were collected at the Grand Mogul Stope waste piles. Samples UASO09, UASO10, and UASO11 were collected at the Grand Mogul Mine waste piles. Samples UASO12, UASO13, and UASO14 were collected at the Mogul Mine waste piles. Figure 3 shows the source soil sample locations. Samples were not collected from the Gold King 7 Level waste pile due to lack of landowner access.

#### **Aqueous Source Samples**

Five aqueous source samples were collected as part of this investigation. Aqueous source samples were collected at adit discharge points at the Grand Mogul Mine, Mogul Mine, Red and Bonita Mine, Gold King 7 Level Mine, and the American Tunnel. Figure 3 shows aqueous source sample locations.

#### **Adit Sediment Source Samples**

Five adit sediment source samples were collected as part of this investigation. Adit sediment source samples were collected at adit discharge points at the Grand Mogul

Mine, Mogul Mine, Red and Bonita Mine, Gold King 7 Level Mine, and the American Tunnel. Figure 3 shows adit sediment sample locations.

## 5.2 SAMPLING METHODS

### 5.2.1 Surface Water Sampling

Surface water sampling was conducted according to UOS TSOP 4.18, "Surface Water Sampling." START personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample, as described in TSOP 4.14, "Water Sample Field Measurements" (UOS 2005b). Field instrumentation was calibrated daily and all calibration and field data were recorded in the field logbook. All surface water samples were collected for dissolved metals because dissolved metals better reflect the impact on sensitive environments. All source and surface water samples designated as dissolved metals were filtered in the field by using a peristaltic pump to draw the water directly through a 0.45 micrometer ( $\mu\text{m}$ ) filter with disposable dedicated Tygon tubing into the sample bottle (Appendix A, photos 22, 25, 39, 45, and 62). Surface water samples designated for total metals analysis were collected directly from the source into the sample bottle. All aqueous metals analysis samples were preserved with nitric acid to a  $\text{pH} < 2$  and stored on ice immediately after collection. Sampling was conducted from the farthest downstream location to the farthest upstream location to minimize the potential for cross-contamination. All surface water sample locations were photographed and documented in the project logbook during sampling activities (Appendices A and C) (UOS 2010).

During surface water sampling, START personnel had planned to assess wetlands to determine if they meet the 40 CFR 230.3 Definition of a Wetland, but the snow cover on the ground was too extensive to observe wetlands (Appendix A, photos 41-44) (OFR 2005).

### 5.2.2 Sediment Sampling

Sediment samples from both streams and adits were collected for total metals and PCB analysis. Sediment sampling was conducted according to UOS TSOP 4.17, "Sediment Sampling" (UOS 2005b). Sediment sampling locations correspond to surface water sampling locations (Figures 4 and 5) (Table 1). START personnel collected sediment

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samples in conjunction with surface water sampling, and collected the sediment sample after the surface water sample had been collected, proceeding from the most downstream location to the most upstream location. START personnel collected sediment samples using a disposable plastic scoop and a sample jar. Samples for total metals were placed in 8-ounce polypropylene jars, and samples for PCB analysis were placed in 8-ounce amber glass jars. Sediment samples were stored on ice. All sediment sample locations were photographed and documented during sample activities (UOS 2010). At locations UASE012, UASE030, and UASE059 there was not enough sediment to collect samples for PCBs, so only metal samples were collected.

### **5.2.3 Source Soil Sampling**

All 14 of the soil samples collected during the SR were source samples and were collected in accordance with procedures described in UOS TSOP 4.16, "Surface and Shallow Depth Soil Sampling" (UOS 2005b). START personnel dug below snow in several locations on each pile and performed XRF analysis of the driest soil in the hole. In-situ XRF analysis showed waste piles were homogeneous, so START personnel collected one grab sample from each distinct area of a waste area; for example, one sample per pile, or one sample on each side of large piles. START personnel used disposable plastic scoops for source sample collection. All source samples were collected as biased grab samples from the 6- to 12-inch depth interval, where possible. The 6- to 12-inch depth interval was chosen because it is below the oxidized layer, but near the surface where exposure to water flow occurs. In the locations in the vicinity of the American Tunnel (UASO01 and UASO02), the ground was too hard to get to the 6-inch depth, and the samples were dug to a depth immediately below the oxidized layer of source material, approximately 2 inches. A pick axe was used to reach the depth needed for the sample and was decontaminated between samples. Sample descriptions were logged in the field logbook. Global Positioning System (GPS) data were collected for each sample location.

### **5.2.4 Adit Water Sampling**

Adit water sampling was conducted according to UOS TSOP 4.18, "Surface Water Sampling." START personnel measured field parameters, including pH, temperature, and electrical conductivity of each sample, as described in TSOP 4.14, "Water Sample Field

Measurements” (UOS 2005b). Field instrumentation was calibrated daily, and all calibration and field data were recorded in the field logbook. All adit water samples were collected for total and dissolved TAL metals. Dissolved metal water samples were drawn through a 0.45 µm filter using a peristaltic pump with disposable dedicated Tygon tubing (Appendix A, photos 22, 25, 39, 45, and 62). Total metal samples were collected by immersing the sample bottles directly in the sample media. The water samples were preserved with nitric acid to a pH <2 and stored on ice. All adit water sample locations were photographed and documented in the project logbook during sampling activities.

### 5.3 ANALYTICAL PARAMETERS

Surface water samples were filtered in the field and delivered for dissolved TAL metals analysis to the EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples were analyzed for both total and dissolved TAL metals by EPA Region 8 ESAT Laboratory in Golden, Colorado. Adit water samples for dissolved metals analysis were also filtered in the field. The standard CLP low concentration water (method SOM01.2) contract quantitation limits are 1 µg/L for lead, 5 µg/L for manganese, 5 µg/L for copper, 1 µg/L for cadmium, and 10 µg/L for zinc (EPA 2010).

The sediment and source soil samples were analyzed through the CLP for TAL total metals and PCBs. The standard CLP (method SOM01.2) contract quantitation limits are 1 milligram per kilogram (mg/kg) for arsenic, 0.5 mg/kg for cadmium, 1 mg/kg for lead, 1.5 mg/kg for manganese, 1 mg/kg for silver, and 6 mg/kg for zinc which are all well below applicable benchmarks for comparison (EPA 2010).

## 6.0 ANALYTICAL RESULTS

The sample data collected during this SR were reviewed using the HRS guidelines for analytical interpretation (OFR 1990). The analytical data is listed in Tables 2 through 8. Elevated concentrations of contaminants reported as three times or more above background contaminant values are noted in the analytical results tables and are determined by sample concentrations based on the following:

- If the background analyte concentration is greater than its Sample Quantitation Limit (SQL), and if the release sample analyte concentration is greater than its SQL, 3 times greater than the background, and 5 times greater than the blank concentration.

- If the background analyte concentration is not greater than its SQL and if the release sample analyte concentration is greater than its SQL, greater than the background Contract Required Detection Limit (CRDL), and 5 times greater than the blank analyte concentration.

Results which exceed background by three times and are in excess of a benchmark are indicated by a closed star (★). Results which exceed background by three times but are not in excess of a benchmark are indicated by an open star (☆). Sample quantitation limits are included in Appendix B.

All of the CLP RAS and Region ESAT laboratory data have been validated. The data validation reports are presented in Appendix B. CLP Form I documents are also presented in Appendix B with the validation reports.

Previous investigations in the Upper Animas Mining District identified the tailings piles and adit discharges from the five main waste areas as sources of contamination, but did not yield conclusive information regarding possible migration of contaminants into the Groundwater Pathway, Surface Water Pathway, and the Soil Exposure Pathway. This SR was performed to determine if any contamination from the Upper Animas Mining District site has migrated into the environment where it is impacting potential environmental and/or human health targets. Contaminants are present at the Upper Cement Creek source areas at levels equal to or greater than SCDM Reference Dose Screening Concentrations (RDSC), Cancer Risk Screening Concentrations (CRSC) or MCLs (EPA 2004). Analytical results for surface water were compared to environmental benchmarks. Analytical results for sediment were compared to background sediment results only because no benchmarks have been established for sediment. Analytical results for soil were compared to SCDM RDSC and CRSC values.

Data gathered as part of this SR concludes that the Surface Water Pathway is affected by metals in sources in the Upper Cement Creek mines in the Upper Animas Mining District site.

## 6.1 SOURCE SOIL/MINE WASTE RESULTS

The source soil samples contained all of the TAL metals in varying amounts. Aluminum concentration ranged from 665 mg/kg at Grand Mogul Mine to 19,500 mg/kg at Mogul Mine. Antimony concentrations ranged from non-detect in the area of the American Tunnel to 13.5 mg/kg at Mogul North Mine. Arsenic concentrations ranged from 9.1 mg/kg at Red and Bonita to 96.8 mg/kg at Grand Mogul. Cadmium concentrations ranged from non-detect at multiple locations to 35.4 mg/kg at Red and Bonita. Copper concentrations ranged from 33.1 mg/kg at Grand Mogul Mine to 4,600 mg/kg at Grand Mogul Mine. Lead concentrations ranged from 241

mg/kg at the American Tunnel to 15,500 mg/kg at Grand Mogul Mine. Magnesium concentrations ranged from non-detect at multiple locations to 12,700 mg/kg at Grand Mogul Mine. Manganese concentrations ranged from 122 mg/kg at Grand Mogul Mine to 5,570 mg/kg at Mogul Mine. Nickel concentrations ranged from non-detect at multiple locations to 9.5 mg/kg at Mogul Mine. Silver concentrations ranged from 1.3 mg/kg at the American Tunnel to 113 mg/kg at Grand Mogul Mine. Zinc concentrations ranged from 102 mg/kg at the American Tunnel to 11,300 mg/kg at Red and Bonita Mine. See Table 4 for source sample results and Figure 3 for soil sample locations and results.

Source soil samples were also submitted for PCB analysis. The only detection for PCBs was in UASO010 collected at Grand Mogul Mine. Arochlor 1248 was detected in UASO010 at a concentration of 12 µg/kg.

## 6.2 AQUEOUS SOURCE RESULTS

Adit/aqueous source water samples contained varying amounts of TAL total (except for sample UASW059 which was analyzed for dissolved metals only) and dissolved metals. Antimony, arsenic, selenium, silver, thallium, and vanadium were non-detect for all total and dissolved samples. Observed total cadmium concentrations ranged from 1.97 µg/L at the American Tunnel portal to 55 µg/L at the Mogul Mine adit. Total copper concentrations ranged from non-detect at the American Tunnel portal and the Red and Bonita portal to 4,030 µg/L at the Gold King 7 Level adit. Total lead concentrations ranged from 3.7 µg/L at the American Tunnel to 271 µg/L at the Mogul Mine adit. Total manganese concentrations ranged from 28,000 µg/L at the Gold King 7 Level to 44,000 µg/L at the American Tunnel portal. Total zinc concentrations ranged from 15,500 µg/L at Red and Bonita Mine to 31,300 µg/L at Mogul Mine.

Observed dissolved cadmium concentrations ranged from 2.02 µg/L at the American Tunnel portal to 105 µg/L at the Grand Mogul Mine. Dissolved copper concentrations ranged from non-detect at the American Tunnel portal and the Red and Bonita portal to 4,690 µg/L at the Grand Mogul Mine. Dissolved lead concentrations ranged from 1.12 µg/L at the American Tunnel to 255 µg/L at the Mogul Mine adit. Dissolved manganese concentrations ranged from 27,800 µg/L at the Gold King 7 Level to 41,700 µg/L at the American Tunnel portal. Total zinc concentrations ranged from 15,400 µg/L at Red and Bonita Mine to 32,700 µg/L at Mogul Mine. See Table 2 for adit water sample results.

### 6.3 ADIT SEDIMENT SOURCE RESULTS

Adit/source sediment samples contained varying amounts of total metals. Beryllium and cadmium were non-detect for all samples. Observed antimony concentrations ranged from non-detect at multiple locations to 23.2 mg/kg at the Grand Mogul Mine. Observed arsenic concentrations ranged from 19.1 mg/kg at the American Tunnel portal to 969 mg/kg at the Grand Mogul Mine. Observed chromium concentrations ranged from non-detect at multiple locations to 7.4 mg/kg at the Red and Bonita Mine adit. Copper concentrations ranged from 11 mg/kg at the Gold King 7 Level to 369 mg/kg at the Red and Bonita Mine adit. Lead concentrations ranged from 59.4 mg/kg at the Red and Bonita Mine adit to 1,740 mg/kg at the Gold King 7 Level adit. Manganese concentrations ranged from 107 mg/kg at the Gold King 7 Level to 2,110 at the Mogul Mine adit. Zinc concentrations ranged from 63.3 mg/kg at Red and Bonita to 524 mg/kg at Grand Mogul Mine. See Table 3 for adit/source sediment sample results.

### 6.4 SELECTION OF SURFACE WATER AND SEDIMENT BACKGROUND VALUES

The Cement Creek Drainage Basin covers a varied geologic terrain that hosts different mineralogical assemblages that were mined at different levels of extraction by different mining methodologies. Mine wastes were accumulated differently at various parts of the basin and sources are composed of various mixes of contaminated mine waste and adit discharges. The selection of just one location as a background was not practical. To determine a representative background, five locations were chosen as backgrounds for this investigation. The highest background value of the five selected locations was taken as the investigation background value for evaluation of the surface water pathway. The analytical results of the five surface water dissolved metals and the resulting background value are presented in Table 5. The analytical results of the five sediment sample TAL total metals results and the resulting background sediment value are presented in Table 7. The five background locations are:

- Sample location UASW003 (A68) located on the Animas River immediately prior to the confluence with Cement Creek, selected because the Animas River is the next drainage east of Cement Creek, originates in the area immediately east of the headwaters of Cement Creek and is the location of moderate mineralization and mining activity;



- Sample location UASW005 (CC17), selected as the most upstream sample location on the South Fork of Cement Creek;
- Sample location UASW012, selected as the most upstream sample location on the North Fork of Cement Creek;
- Sample location UASW030 (CC01F), selected as the most upstream location in the Lower Ross Basin; and
- Sample location USSW045, selected from Minnesota Gulch, a tributary stream from the western side of the Cement Creek Basin that is located in mineralized terrain with minimal mining activity.

## 6.5 SURFACE WATER RESULTS

The surface water dissolved metals analytical data is presented in Table 6 in a most upstream to most downstream sequence. None of the analytical results that were greater than 3 times background were qualified as J, J-, or J+; therefore, none of the analytical data was required to be adjusted per the EPA's 1996 guidance document "EPA 540-F-94-028—Using Qualified Data to Document an Observed Release and Observed Contamination." The surface water dissolved analytical results reveal that concentrations of seven dissolved metals (aluminum, cadmium, copper, iron, lead, nickel, and zinc) are greater than 3 times the background dissolved surface water value and greater than an SCDM benchmark. The dissolved aqueous concentrations of three additional metals (beryllium, cobalt, and manganese) that do not have an SCDM benchmark also occur at concentrations greater than 3 times background.

Iron and zinc both occur at elevated concentrations (greater than 3 times background and greater than an SCDM benchmark) in 23 of the dissolved surface water samples throughout the Cement Creek stream course. Elevated concentrations of aluminum occur at three locations in the upper half of the Cement Creek drainage. The SCDM ecological toxicity of these three metals is low (aluminum 100 µg/l, iron 10 µg/l, and zinc 10 µg/l) (EPA 2004).

Nickel with an SCDM ecological toxicity of 100 is found in an elevated concentration at one location in Cement Creek (UASW009) just below the confluence with the North Fork of Cement Creek.

Dissolved copper and lead are both detected in elevated concentrations at four locations in the middle section of Cement Creek. The SCDM ecological toxicity of copper and lead is 1,000

(EPA 2004). Cadmium occurs at elevated concentrations at 10 sample locations (Table 6). These locations bracket a series of small wetlands found in the upper half of the Cement Creek drainage. The SCDM ecological toxicity of cadmium is 10,000 (EPA 2004).

Beryllium, cobalt, and manganese are all detected at greater than 3 times background in the dissolved surface water analyses from Cement Creek, but these three elements do not have an associated SCDM benchmark (Table 6) (EPA 2004). Manganese was detected at 14 locations most of which are located in the middle section of Cement Creek (Table 6).

See Table 5 for the background dissolved surface water value determination, Table 6 for the dissolved surface water sample results, and Figure 4 for sample locations.

## 6.6 SEDIMENT RESULTS

The sediment analytical results are presented in Table 8 in sample numeric order. The analytical results were reviewed and the qualified results ("J, J+, and J-") were adjusted using EPA's 1996 guidance document "EPA 540-F-94-028-Using Qualified Data to Document an Observed Release and Observed Contamination." These adjustments result in a conservative evaluation of the analytical results.

There are no benchmarks for sediments which prevent any Level I designations of the analytical results.

Iron was found at concentrations greater than 3 times background in the sediment at six locations (UASE007, UASE011, UASE014, UASE046, UASE058). Silver was found at concentrations greater than 3 times background in the sediment at one location (UASE006).

Sediment samples were also submitted for PBC analysis. No PCBs were detected in sediment samples above method detection limits.

See Table 7 for the background sediment value determination, Table 8 for the sediment sample results, and Figure 4 for the co-located surface water sample locations. Adit sediment samples are discussed separately under Section 6.3.

## 7.0 SOURCES AND WASTE CHARACTERIZATION

This investigation identifies five significant sources in the Upper Cement Creek drainage from which contamination has migrated to the environment. These sources are:

- Grand Mogul Mine – three waste rock piles and one aqueous mine discharge;
- Mogul Mine – one waste rock pile and one aqueous discharge;
- Red and Bonita Mine - one waste rock pile and one aqueous discharge;
- Gold King 7 Level Mine – waste rock piles and an aqueous discharge; and
- American Tunnel – aqueous discharge.

Source sample locations are displayed in Figure 3. All source sample results are also displayed in Tables 2, 3, and 4. Photographs of the sample locations are presented under separate cover in Appendix A.

The first source area consists of the three waste rock piles and mine discharge at Grand Mogul Mine (Appendix A, photos 58-60 and 63-67). The waste rock piles near the portal of the mine are uncovered and easily accessible via the adjacent county road. The waste rock at Grand Mogul Mine consists of three waste rock piles. The Lower Waste pile is estimated to contain 845 cubic yards, the Stope Complex pile 6,926 cubic yards, and the Eastern Waste pile 18,720 cubic yards (UOS 2011c) for a total of with an estimated total volume of 26,581 cubic yards. Water that is exposed to the waste piles flows into Cement Creek. Metals observed in the waste rock samples (UASO009, UASO010, and UASO011, Table 4) include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, thallium, sodium, vanadium, and zinc.

Grand Mogul mine has a collapsed adit, which has had flow rates recorded between 0.004 cfs in September 2009 and 0.157 cfs in June 2009 (Appendix A, photos 46, 63, and 68-70) (EPA 2011). Metals observed in the mine discharge (UASW059, Table 2) include aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, and zinc.

The second source area consists of a single waste rock pile and an adit discharge from Mogul Mine (Appendix A, photos 46, 63, and 68-70). The waste rock pile is uncovered and easily accessible via the adjacent county road. The waste rock at Mogul Mine consists of one waste rock pile with a volume of 41,374 cubic yards (UOS 2011c). Metals observed in the waste rock samples (UASO012, UASO013, and UASO014, Table 4) include aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium,

cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, silver, thallium, sodium, vanadium, and zinc.

The adit discharge from Mogul Mine passes through a wetland area, where it enters Cement Creek (Appendix A, photo 46). Mogul Mine has a flumed adit, which has had flow rates recorded between 0.095 cfs in July 2010 and 0.178 cfs in July 2009 (EPA 2011). Metals observed in the mine discharge (UAAD004, Table 2) include aluminum, arsenic, beryllium, cadmium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, sodium, and zinc.

The third source area consists of two waste rock piles and an adit discharge from the Red and Bonita Mine (Appendix A, photos 35 and 48-51). The waste rock piles are uncovered and easily accessible via the adjacent county road. The waste rock at Red and Bonita Mine consists of two waste rock piles; Tier 1 pile at 3,160 cubic yards and Tier 2 pile at 802 cubic yards for a total volume of 3,962 cubic yards (UOS 2011b). The adit discharge from the Red and Bonita Mine flows over waste rock piles, where it is channeled through an iron bog and into Cement Creek (Appendix A, photo 35). Metals observed in the waste rock samples (UASO003, UASO004, and UASO005, Table 4) include aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, silver, thallium, vanadium, and zinc. Red and Bonita Mine has a collapsed adit, which has had flow rates recorded between 0.403 cfs in April 2010 and 0.749 cfs in May 2009 (EPA 2011) (Appendix A, photo 35). Metals observed in the mine waste (UAAD003, Table 4) include aluminum, arsenic, beryllium, cadmium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, sodium, and zinc.

The fourth source area consists of the waste rock piles and adit discharge from the Gold King 7 Level Mine (Appendix A, photos 38 and 74). The waste rock piles are uncovered and easily accessible via the adjacent county road. The waste rock piles were not sampled as a part of this investigation because the EPA obtained landowner access to sample only the aqueous adit discharge. The adit discharge from the Gold King 7 Level Mine is channeled through a culvert system and flows into the North Fork of Cement Creek. The North Fork of Cement Creek joins with the main stem of Cement Creek downstream of the Red and Bonita Mine. The Gold King 7 Level mine has a flumed adit, which has had flow rates recorded between 0.333 cfs in April 2010 and 0.558 cfs in June 2010 (EPA 2011). Metals observed in the mine discharge (UAAD002, Table 2) collected at the point where water exits the mine tunnel, include aluminum, arsenic, beryllium, cadmium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, sodium, and zinc.

The fifth source area consists of waste rock and discharge from the American Tunnel (Appendix A, photos 27, 28, and 47). The American Tunnel discharge consists of a portal which flows through a channel (including a flume) into Cement Creek. Flows at the American Tunnel have been observed between 0.178 cfs in February 2010 and 0.318 cfs in May 2009. There was also waste rock in the vicinity of the American Tunnel Portal. The original volume of waste rock is not known, because an unknown portion of this area was reclaimed.

Between October 25 and November 2, 2010, START collected samples from each of the potential sources and sent them to a CLP laboratory or the Region 8 ESAT laboratory for metals analysis. The source soil samples and source aqueous samples contained all of the TAL metals in varying amounts. Metals found in the sources that potentially may affect targets along the surface water pathway include cadmium, lead, manganese, and zinc. See the analytical results in Section 6.0 of this report for information regarding each metal.

## **8.0 GROUNDWATER PATHWAY AND TARGETS**

A review of the groundwater well records for wells in the Cement Creek drainage maintained by the State of Colorado Division of Water Resources identified seven domestic or household use wells (Division of Water Resources 2009). It is not currently documented if the wells in the Cement Creek drainage are used for obtaining drinking water.

The Town of Silverton does not utilize groundwater as a source of municipal water (Town of Silverton 2009).

The groundwater pathway was not included as part of this investigation.

## **9.0 SURFACE WATER PATHWAY AND TARGETS**

The surface water pathway is the pathway most impacted by mining and milling activities in the Cement Creek drainage. Millions of tons of mine and mill waste were dumped directly into the area streams as a normal operating practice between 1890 and 1935 and to a far lesser extent until 1991 (USGS 2007c). The fine-grained material has had ample opportunity to spread unimpeded downstream and contaminate stream sediment as far as the Animas River.

The sources of impact to surface water in the Cement Creek drainage are adit discharges and water flow over waste piles. The main inflows contributing to surface water contamination are located at the Grand

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Mogul Mine, Mogul Mine, Red and Bonita Mine, American Tunnel, and Gold King 7 Level Mine. The probable point of entry (PPE) at each of these locations is the point where surface water flow enters Cement Creek either in the form of an adit discharge or surface water flow over mine waste. The PPE that extends furthest downstream in the Animas River from the Upper Animas Mining District site is the PPE from the American Tunnel (Figure 1).

There is no documentation of surface water intakes for drinking water, agricultural, or industrial use along Cement Creek or the Animas River within the aggregate 15-mile downstream limit. The first use of surface water below the confluence of Cement Creek with the Animas River is the Tall Timber Ditch Alternative Point which is located 17 miles downstream of Silverton, Colorado. The ditch has historically been used for irrigation and is owned by Beggrow Enterprises of Durango, Colorado (Colorado Division of Water Resources 2009). The Animas River is used for occasional sport recreational use (e.g., rafting) within the 15-mile downstream limit, but the relative inaccessibility of the river along much of the stream course mitigates against active recreational use along the entire stretch (Mild to Wild Rafting 2009).

Town of Silverton does not have a municipal intake on Cement Creek or the Animas River, but obtains its drinking water supply from Bear and Boulder Creeks. Bear Creek is located in unmineralized terrain of the Mineral Creek drainage west-southwest of Silverton between Bear and Sultan Mountains outside the area of influence of Cement Creek. Boulder Creek flows into the Animas River northeast of Silverton after it passes around the Mayflower Tailings Ponds via a diversion (USGS 1955, Town of Silverton 2009).

Cement Creek is not a fishery; however, the Animas River below Silverton is stocked and fished (Colorado Division of Wildlife [CDOW] 2009). Rainbow, brook, and native trout are caught in the Animas River below Silverton, and anecdotal accounts report that the fish are consumed by humans (Outdoor World 2009). Elk Park, located approximately 5 miles downstream of Silverton on the Animas River and accessible only on foot, was specifically identified as a location where fishermen catch and consume fish (Figure 1) (Outdoor World 2009). Elk Park is also the site of a CDOW electro-fishing study with data from 2005 and 2010 where a reduction in fish population was noted between 2005 and 2010 (CDOW 2011).

Approximately 2,500 feet of streamside wetlands are estimated to be found along Cement Creek (U.S. Department of the Interior, Fish and Wildlife Service [USDOI] 1998a, c). Iron bogs are found along the middle stretch of Cement Creek. Approximately 3 miles of palustrine and riverine streamside wetlands

are estimated to be found along the 15-mile downstream segment of Cement Creek and the Animas River below the PPE of the American Tunnel at Cement Creek (USDOl 1998b, d).

A rare form of sphagnum moss (*Sphagnum obtusum*) has been identified at the confluence of the North Fork of Cement Creek with Cement Creek (Michigan Tech University 2011). Other sensitive environments and other threatened and endangered species present in the area include the Canada Lynx (threatened) and the Southwest Willow Flycatcher (endangered), and the Uncompahgre fritillary butterfly (endangered) (U.S. Department of the Interior, Fish and Wildlife Service (USDOl). 2011).

START collected surface water samples from Cement Creek, adit discharges, and the Animas River in late October and early November of 2010. Four background samples were collected from locations on Cement Creek, and one background sample was collected on the Animas River upstream of the confluence with Cement Creek. Surface water samples indicated that concentrations of aluminum, beryllium, cadmium, copper, iron, lead, manganese, nickel, and zinc were found at levels at least 3 times the background level. Cadmium is the most widespread contaminant and is found in several samples that include an estimated 2,500 feet of streamside wetlands. See the surface water analytical results in Section 6.0, as well as Table 6 and Figure 4 in this report, for the concentrations of each metal. Sediment samples indicated that concentrations of antimony, arsenic, iron, and silver were present in a limited number of samples. The highest concentration of sediment contamination was in Cement Creek at the toe of the Grand Mogul Mine (UASE09) (Table 8).

## 10.0 SOIL EXPOSURE PATHWAY AND TARGETS

The Cement Creek area within the Upper Animas Mining District has several sources of mine waste. In October and November 2010, START collected soil samples from waste rock piles in the Upper Animas Mining District Site. The sources examined as a part of this investigation included soil from the vicinity of the American Tunnel, the Red and Bonita Mine, Mogul Mine, Grand Mogul Mine, Mogul North Mine, and the Grand Mogul Stope. A soil sample could not be collected from the Gold King 7 Level Mine due to sampling limits in the access agreement with the property owner.

The mine sites have very little vegetation and no containment, and mine tailings and waste rock remain exposed to the elements. Access to the mine sites is not restricted in any way. The adjacent roads are used for recreation by ATVs and driven on by hunters and tourists in the area. There are no residents or workers on the mine sites, and it is unknown if any people reside in the vicinity of the mine sites.

The lynx, which has been observed in the area, is a federally listed threatened and state-listed endangered species, and the Boreal toad is a state-listed endangered species (CDOW 2010). The Boreal toad could live in wetlands adjacent to the Cement Creek (CDOW 2010).

## **11.0 AIR PATHWAY AND TARGETS**

The air pathway was not evaluated as a part of this site reassessment because of the reportedly very low population density in the Cement Creek drainage and the fact that the ground surface is snow-covered for at least 6 months out of the year.

## **12.0 DATA QUALITY ANALYSIS**

### **12.1 DATA QUALITY OBJECTIVES**

The EPA DQO Process is a seven-step systematic planning approach to develop acceptance or performance criteria for EPA-funded projects. Based upon the risks associated with the hazardous substances, the project team identified surface water and soil exposure as the pathways of potential concern at the site. Surface water and sediment samples were used to determine if there was a significant release of contaminants in the Surface Water Pathway. Soil samples were collected to determine the potential for contamination in Cement Creek by flow over mine waste.

This SR was prompted by the many concerns surrounding the Upper Animas Mining District site. The principal goal of this study was to determine if contamination from the Upper Animas Mining District has migrated into the environment where it is impacting potential environmental and/or human health targets in the surface water pathway.

The primary study questions for this investigation that were answered by the results of this investigation were:

1. Determining if waste piles and draining adits contained elevated concentrations of metals;
2. Determining if surface waters and sediments in Cement Creek and the Animas River were impacted by sources at the former mine sites;
3. Determining if environmental sample concentrations of metals exceed applicable benchmarks; and



4. Determining if elevated concentrations of metals and PCBs identified in the surface water and sediments are attributable to the sources at the former mine sites.

Fifty-four surface water samples and 54 sediment samples plus 3 duplicate surface water and sediment samples were collected in October 2010 from the Animas River, Cement Creek, and their tributaries within the study area to try to attribute contamination in Cement Creek and the Animas River to various sources.

Fourteen source soil samples and four aqueous source samples were collected in October 2010 from the potential sources and the mines in the Upper Animas Mining District.

All analytical data have been reviewed and verified to ensure that data is acceptable for the intended use (Appendix B). The Data Quality Objectives for this project have been met and the data collected is of sufficient quality to answer the study questions.

## 12.2 DATA VALIDATION AND INTERPRETATION

All data analyzed by the CLP RAS laboratories were validated by a third party subcontracted chemist. All data are acceptable for use as qualified in the data validation report. The data validation report, laboratory forms, and SQL calculations are presented in Appendix B.

There were some qualifications applied to each inorganic data package associated with this sampling event. The ESAT Inductively coupled plasma mass spectroscopy ICMPS data package DG-216 had a "U" qualifier applied to all silver and molybdenum results because silver and molybdenum were detected in the prep blanks. A "J+" qualifier was added to all beryllium results because the calibration showed slightly high results for beryllium.

The CLP Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) data package MH35H7 for the sediment samples had a qualifier "U" applied to antimony for 11 samples because antimony was detected in the blank. A "U" qualifier was applied to beryllium results for 14 samples because beryllium was detected in the blank. A "U" qualifier was applied to cadmium results for six samples because cadmium was detected in the blank. A "U" qualifier was applied to chromium results for three samples because chromium was detected in the blank. A "U" qualifier was applied to cobalt results for six samples because cobalt was detected in the blank. A "U" qualifier was applied to magnesium results for eight samples because magnesium was detected in the blank. A "U" qualifier was applied to nickel results for six samples because nickel

was detected in the blank. A "U" qualifier was applied to selenium results for 18 samples because selenium was detected in the blank. A "U" qualifier was applied to silver results for one sample because silver was detected in the blank. A "J+" qualifier was applied to beryllium results for five samples because of interference check exceedance and positive interference. The "J-" qualifier was applied to thallium for negative interference on 10 samples. All samples had a "J" or "UJ" applied for copper and lead because the original and duplicate were both greater than 5 times the CRDL, and the Relative Percent Difference (RPD) was greater than 20 percent. All samples had a "J" or "UJ" applied for antimony and silver because the spike recoveries were outside control limits. All samples had a "J+" applied for barium and copper because no post-digest spike was performed. All samples had a "J+" applied for arsenic because spike recoveries were outside control limits. All samples had a "J" or "UJ" applied for arsenic, beryllium, cadmium, copper, nickel, and zinc because the dilutions were greater than 10 percent, and the result was at least 50 times the MDL.

The CLP ICP-AES data package MH35L0 for the sediment samples had a qualifier "U" applied to antimony for nine samples because antimony was detected in the blank. A "U" qualifier was applied to beryllium results for eight samples because beryllium was detected in the blank. A "U" qualifier was applied to cadmium results for four samples because cadmium was detected in the blank. A "U" qualifier was applied to chromium results for two samples because chromium was detected in the blank. A "U" qualifier was applied to cobalt results for two samples because cobalt was detected in the blank. A "U" qualifier was applied to nickel results for one sample because nickel was detected in the blank. A "U" qualifier was applied to selenium results for 10 samples because selenium was detected in the blank. A "U" qualifier was applied to silver results for two samples because silver was detected in the blank. A "J+" qualifier was applied to beryllium results for two samples because of interference check exceedance and positive interference. Thallium was qualified "J+" for interference check exceedance and positive interference in all samples. A "J+" qualifier was applied to silver results for eight samples because of interference check exceedance and positive interference. All samples had a "J-" or "UJ" applied for selenium and thallium because the post-digestion spike recoveries were outside control limits. All samples had a "J" or "UJ" applied for antimony and silver because the post-digestion spike recoveries were outside control limits. All samples had a "J+" applied for arsenic because spike recoveries were outside control limits. All samples had a "J" applied for arsenic, lead, and zinc because the dilutions were greater than 10 percent.

The CLP ICP-AES data package MH35E5 for the sediment samples had a qualifier "U" applied to antimony for all samples because antimony was detected in the blank. A "U" qualifier was applied to beryllium results for 15 samples because beryllium was detected in the blank. A "U" qualifier was applied to cadmium results for ten samples because cadmium was detected in the blank. A "U" qualifier was applied to chromium results for one sample because chromium was detected in the blank. A "U" qualifier was applied to magnesium results for one sample because magnesium was detected in the blank. A "U" qualifier was applied to silver results for two samples because silver was detected in the blank. A "U" qualifier was applied to thallium results for 16 samples because thallium was detected in the blank. A "J+" qualifier was applied to beryllium results for five samples because of interference check exceedance and positive interference. A "J+" qualifier was applied to silver results for 18 samples because of interference check exceedance and positive interference. A "J+" qualifier was applied to thallium results for four samples because of interference check exceedance and positive interference. All samples had a "J" or "UJ" applied for barium and zinc because the original and duplicate were both 5 times the CRDL, and the RPD was greater than 20 percent. All samples had a "J" or "UJ" applied for cadmium because the original and duplicate were both 5 times the CRDL, the absolute difference was greater than the CRQL, and post-digestion spike recoveries were outside control limits. All samples had a "J" qualifier applied for copper because the post-digestion spike recoveries were outside control limits. All samples had a "J" qualifier applied for arsenic, beryllium, cadmium, cobalt, copper, and zinc because the dilutions were greater than 10 percent.

The CLP ICP-AES data package MH35G5 for the sediment samples had a qualifier "U" applied to antimony for 18 samples because antimony was detected in the blank. A "U" qualifier was applied to beryllium results for 18 samples because beryllium was detected in the blank. A "U" qualifier was applied to cadmium results for 15 samples because cadmium was detected in the blank. A "U" qualifier was applied to chromium results for one sample because chromium was detected in the blank. A "U" qualifier was applied to cobalt results for five samples because cobalt was detected in the blank. A "U" qualifier was applied to magnesium results for nine samples because magnesium was detected in the blank. A "U" qualifier was applied to nickel results for four samples because nickel was detected in the blank. A "U" qualifier was applied to selenium results for 20 samples because selenium was detected in the blank. A "U" qualifier was applied to silver results for seven samples because silver was detected in the blank. A "U" qualifier was applied to thallium results for 17 samples because thallium was detected in the blank. A "J+" qualifier was applied to beryllium results for two samples because of interference

check exceedance and positive interference. A "UJ" qualifier was applied to thallium for all samples due to a potentially false negative detection in the interference check. All samples had a "J-" or "UJ" qualifier applied for selenium and zinc because the post-digestion spike recoveries were outside control limits. All samples had a "J" or "UJ" qualifier applied for antimony and silver because the post-digestion spike recoveries were outside control limits. All samples had a "J" qualifier applied for arsenic, beryllium, cadmium, chromium, copper, manganese, nickel, and zinc because the dilutions were greater than 10 percent.

### 13.0 MEASUREMENT QUALITY OBJECTIVES

#### 13.1 FIELD QUALITY CONTROL PROCEDURES

All samples were handled and preserved as described in UOS TSOP 4.2, "Sample Containers, Preservation, and Maximum Holding Times." Calibration of the pH, temperature, and conductivity meters followed instrument manufacturers' instruction manuals and UOS TSOP 4.14, "Water Sample Field Measurements." Sample collection progressed from downstream to upstream to prevent cross-contamination (UOS 2005b).

The following samples were collected to evaluate quality assurance at the site in accordance with the "Guidance for Performing Site Inspections under CERCLA," Interim Final September 1992, the "Region 8 Supplement to Guidance for Performing Site Inspections under CERCLA," and the UOS Generic QAPP (EPA 1992, 1993; UOS 2005a):

- Three double volume sediment samples and three double volume surface water samples were used for a MS/MSD. (The double volume samples were not labeled as separate samples.) The percent recoveries and relative differences were within QC limits except for analytes noted in Section 12.2.
- Three field surface water duplicates were collected; the duplicate sample was blind to the lab. The percent difference for the water samples was 4.3 percent.
- Three field sediment duplicates were collected; the duplicate sample was blind to the lab. The percent difference for the water samples was 22.5 percent.

The UOS Generic QAPP serves as the primary guide for the integration of QA/QC procedures for the START contract (UOS 2005a).

## 13.2 DATA QUALITY INDICATORS

Quality attributes are qualitative and quantitative characteristics of the collected data. The principle quality attributes to environmental studies are precision, bias, representativeness, comparability, completeness, and sensitivity. Data quality indicators (DQIs) are specific indicators of quality attributes. The following DQIs were considered during the review of field collection techniques and field QA/QC results, as well as laboratory QA/QC.

### 13.2.1 Bias

Bias is systematic or persistent distortion of a measurement process that causes errors in one direction. The extent of bias can be determined by an evaluation of laboratory initial calibration/continuing calibration verification, laboratory control spike/laboratory control, interference checks, spike duplicates, blank spike, MS/MSD, method blank, and trip blank.

A review of the ESAT forms for water samples analyzed for metals detected a high bias in the data set DG-216 for beryllium. There was a positive interference for these metals in the interference check samples. These results were qualified as "J+."

A review of the CLP forms for soil/sediment samples analyzed for metals detected a high bias in the data sets MH35G5, MH35E5, MH35H7, and MH35L0 for beryllium. Silver and thallium results were biased high in data packages MH35E5 and MH35L0. There was a positive interference for these metals in the interference check samples. These results were qualified as "J+."

Thallium results were biased low in data packages MH35H7 and MH35G5 because there was a negative interference for these metals in the interference check samples, and the results were qualified "J-/UJ."

### 13.2.2 Sensitivity

Sensitivity generally refers to the capability of a method or instrument to discriminate between small differences in analyte concentration and is generally discussed as detection limits. Before sampling begins, it is important to compare detection limits and project

requirements in order to select a method with the necessary detection limits to meet the project goals. The detection limits are described in the analytical methods.

All detection limits met the CLP requirements; therefore, all sensitivity requirements for the project were met.

### **13.2.3 Precision**

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions and is expressed as the relative percent difference (RPD) between the sample pairs. The field duplicate and MS/MSD were used to evaluate precision.

The average RPD was 4.3 percent for the surface water samples and 22.5 percent for sediment samples. RPD results are presented in Table 9.

### **13.2.4 Representativeness**

Representativeness is the measure of the degree to which data accurately and precisely represents a characteristic of a population parameter, variations at a sampling point, a process condition, or an environmental condition. Representativeness was achieved by adherence to TSOPs for sampling procedures, field and laboratory QA/QC procedures, appropriateness of sample material collected, analytical method and sample preparation, and achievement of acceptance criteria documented in the FSP for the project. Some deviations from the FSP were documented in the field logbook.

The following deviations from the final FSP, dated October 21, 2010, were made in the field based on assessments made by the UOS project manager:

- Samples UASW038 and UASE038 (Illinois Gulch) were not collected because the confluence of Illinois Gulch and Cement Creek was located on private property for which START did not have an access agreement.
- Samples UASW048 and UASE048 (Elk Tunnel discharge) were not collected because START personnel could not identify any flow from Elk Tunnel.

- Samples UASW051 and UASE051 (Mammoth Tunnel discharge) were not collected because START personnel could not identify any flow from Mammoth Tunnel.
- Samples UASW053 and UASE053 (Cement Creek downstream of Prospect Gulch) were not collected because they were located on private property for which START did not have an access agreement.
- Samples UASW055 and UASE055 (Cement Creek upstream of Prospect Gulch) were not collected because they were located on private property for which START did not have an access agreement.
- Samples UASW057 and UASE057 (Dry Gulch discharge) were not collected because START personnel could not identify any flow from Dry Gulch.
- The planned location for samples UASW011 and UASE011 was below all of the Gold King 7 Level waste piles. These samples were instead collected where runoff from the upper piles crosses the mine access road. The planned location could not be safely accessed at the toe of the lower piles due to an extremely steep slope, loose material, and snow.
- In addition to adit water, sediment samples were collected from adit discharge points, as START determined it would provide additional information.
- Fewer soil samples than planned were collected. START personnel dug below snow in several locations on each pile and performed XRF analysis of the driest soil in the hole. In-situ XRF analysis showed waste piles were more homogeneous than expected, so the number of samples required for characterization was reduced.
- Soil samples collected in the vicinity of the American Tunnel, UASO001 and UASO002, were obtained from 0 to 1 inch below ground surface because the ground was frozen and the planned depth of 6 inches could not be obtained.
- Soil samples were not collected at the Gold King 7 Level Mine because the waste piles for which START had an access agreement could not be accessed due to unsafe conditions, including extremely steep slope, loose waste rock material, and snow.
- A sediment sample for PCB analysis was not collected at UASE059 (at the toe of Grand Mogul Mine) because there was not enough sediment available for

both metals and PCB analysis. Metals analysis was deemed more critical to project goals.

- A sediment sample for PCB analysis was not collected at UASE012 (above Gold King 7 Level Mine) because there was not enough sediment available for both metals and PCB analysis. Metals analysis was deemed more critical to project goals.
- A sediment sample for PCB analysis was not collected at UASE030 (Cement Creek upstream of Grand Mogul Mine) because there was not enough sediment available for both metals and PCB analysis. Metals analysis was deemed more critical to project goals.
- Sample AD005 was not collected because there is no adit discharge from Grand Mogul Mine.
- Surface water and sediment samples were not collected at locations 025, 026, 027, 028, and 031 because START was not able to reach the highest elevations due to snowy and potentially unsafe conditions.
- Soil samples were not collected from the Queen Anne Mine, the Adelphin Mine, and the Columbia Mine because START was not able to reach the highest elevations due to snowy and potentially unsafe conditions.
- Documentation of overland flow to Cement Creek was not possible due to extensive snow cover.
- Documentation of wetlands and other sensitive environments was not possible due to extensive snow cover.

#### 13.2.5 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system. The percent completeness for this project was 81 percent. Samples were collected in accordance with the FSP, except where snowy and/or hazardous conditions or access restrictions prevented collection of planned samples.

#### 13.2.6 Comparability

Comparability is the qualitative term that expresses the confidence that two data sets can contribute to common interpretation and analysis and is used to describe how well samples within a data set, as well as two independent data sets, are interchangeable.



Validated lab data were obtained to ensure comparability to previous sampling events. All samples were sent to a CLP laboratory or the Region 8 ESAT laboratory, and all data were validated (Appendix B).

All samples were collected using the same FSP, TSOPs, and sampling equipment; therefore, all sample data are comparable.

#### 14.0 DATA GAPS

Because of the snow cover in the Cement Creek drainage during the late October and early November 2010 sampling event, several key data elements were not collected. These data gaps include:

- Waste rock/Source samples from the waste rock piles at the Gold King 7 Level Mine and the higher Queen Anne, Adelphin, and Columbia mines;
- Estimates of volume of waste rock material at all the source locations.
- Delineation of wetlands along Cement Creek and determination of wetland qualification for HRS scoring;
- Documentation of the presence of sensitive environment and or threatened and endangered species in the Cement Creek drainage and the Animas River below Silverton, Colorado
- Documentation of recreational fishing and human fish consumption along the 15-mile downstream limit.
- Ultimate disposition of remediated materials at the various mines that have been remediated in the past;
- Evaluation of containment factor values of identified sources for surface water pathway migration as found in Table 4.2 of HRS Rule; and
- Groundwater users in the Cement Creek drainage.

#### 15.0 SUMMARY

The Upper Animas Mining District has a 100-year history of mining and milling in the mountains surrounding Silverton, Colorado. Eight major sources have been identified in the Cement Creek drainage: the Grand Mogul Mine (three waste rock piles and one aqueous discharge); the Mogul Mine (one waste pile and one aqueous discharge); the Red and Bonita Mine (one waste pile and one aqueous discharge); Gold King 7 Level Mine; American Tunnel (aqueous discharge); and the three potential uppermost

sources the Queen Anne, Adelphin, and Columbia mines as well as the waste pile from the Gold King 7 Level Mine which were not sampled as a part of this investigation. The sampled sources contained concentrations of aluminum, antimony, arsenic, beryllium, cadmium, copper, iron, lead, manganese, nickel, silver, and zinc. The quantity of source materials for evaluation of these sources in this investigation was derived from documents of previous investigations.

An appropriate background value for surface water and sediment from this large and geologically varied drainage basin was determined by selecting five background locations and using the highest background value from the five selected locations for each analyte as the investigation background. An observed release of aluminum, cadmium, copper, iron, manganese, lead, and zinc to the surface water pathway is documented from the surface water and sediment results of samples collected from Cement Creek in the autumn of 2010. Cadmium, copper, lead, and zinc concentrations are significant in evaluation of this site. The concentrations of cadmium, copper, lead, and zinc in several surface water samples were 3 times the background surface water value and exceed the applicable SCDM benchmark. The manganese concentrations in surface water samples were 3 times background but do not have an applicable SCDM benchmark.

There are limited occurrences of metals in the sediment greater than 3 times background; however there are no applicable SCDM benchmarks for metals in sediments, which limit the impact of sediment contamination in the evaluation of this site.

Mine waste rock and sediments were analyzed for PCBs. PCBs were not detected in the Cement Creek stream sediments and only one isolated low-level detection was recorded in the mine waste rock at the Grand Mogul Mine.

Environmental and human health targets have been identified within the reach of Cement Creek that is documented to have releases from the identified sources. These targets include an estimated 2,500 streamside feet of small wetlands and potential sensitive environments for plants and animals. While Cement Creek itself is not a fishery, there is evidence that the Animas River below the confluence with Cement Creek is an active fishery where fish are caught and probably consumed by sports fishermen. There is no documentation that surface water from Cement Creek and the Animas River within the 15-mile downstream limit is used as a source of drinking water.

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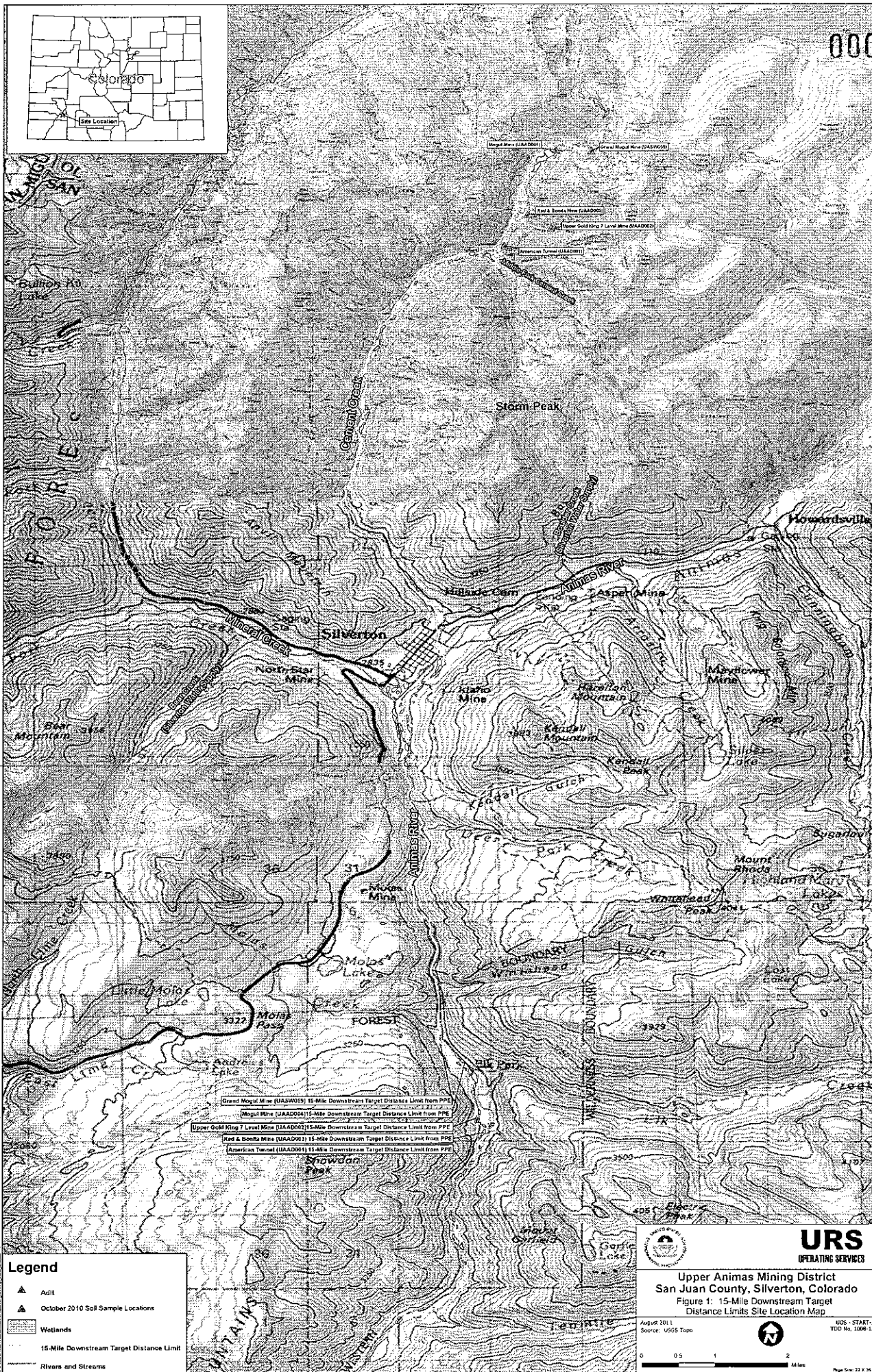
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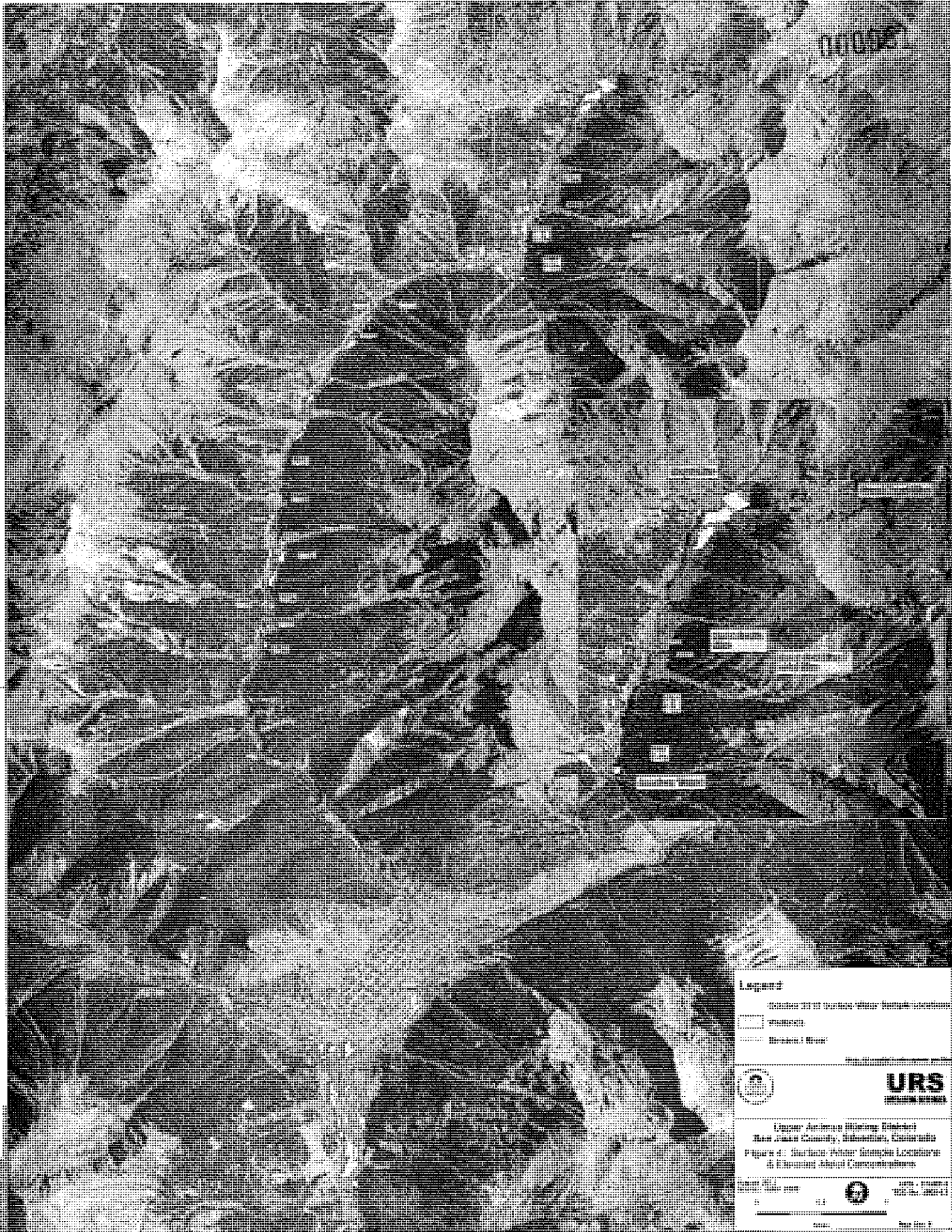








00056




**Legend**

Number of 10 Sample Water Sample Location

□ Station

— Boundary Line

 **URS**  
Engineering & Construction

Upper Anderson River District  
San Juan County, New Mexico, Colorado

Figure 4: Surface Water Sample Locations  
at Elevated Metal Concentrations

Scale: 1:10,000

North Arrow

Scale: 1:10,000

00005

**Legend**

- October 2000 Sediment Sample Location
- Stream / Contour
- Waterbody



**URS**  
CONSULTANTS

Upper Arroyo Valley District  
San Juan County, Colorado, Colorado  
Figure 2. Sediment Sample Locations &  
Stream Network Contours

Scale: 1:10,000  
North Arrow

North

Scale: 1:10,000  
North Arrow

**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Surface Water	UASW001	-	Animas River downstream of the confluence with Cement Creek	Determine the impact of Cement Creek on the Animas River and the fisheries it supports		37.80955582	-107.6604985
Surface Water	UASW002	-	Cement Creek immediately upstream of the confluence with the Animas River	Determine contaminant concentrations in Cement Creek immediately upstream of the confluence with Animas River		37.8097218	-107.6605579
Surface Water	UASW003	A68	Animas River upstream of the confluence with Cement Creek	Establish background concentrations in the Animas River	1 of 5 Background Samples	37.8107356	-107.6595997
Surface Water	UASW004	-	Cement Creek downstream of the confluence with the South Fork of Cement Creek	Determine the impact of the South Fork of Cement Creek on Cement Creek		37.88922024	-107.6574425
Surface Water	UASW005	CC17	South Fork of Cement Creek	Determine contaminant concentrations in South Fork of Cement Creek	1 of 5 Background Samples, Duplicate, and MS/MSD	37.88958969	-107.6530445
Surface Water	UASW006	-	Cement Creek downstream of the American Tunnel and upstream of the confluence with the South Fork of Cement Creek	Determine the impact of the American Tunnel discharge on Cement Creek		37.8898256	-107.6531778
Surface Water	UASW007	CC18	Discharge from the American Tunnel immediately above confluence with Cement Creek	Determine contaminant concentrations in the American Tunnel Discharge		37.89187922	-107.6486617
Surface Water	UASW008	-	Cement Creek upstream of the American Tunnel	Determine contaminant concentrations in Cement Creek upstream of the confluence with the American Tunnel discharge		37.89248894	-107.6484147
Surface Water	UASW009	-	Cement Creek downstream of the confluence with the North Fork of Cement Creek	Determine the impact of the North Fork of Cement Creek on Cement Creek		37.89488872	-107.6472536
Surface Water	UASW010	-	North Fork of Cement Creek upstream of the confluence with Cement Creek	Determine contaminant concentrations in the North Fork of Cement Creek		37.89086142	-107.6470243
Surface Water	UASW011	-	North Fork of Cement Creek downstream of the Gold King 7 Level Mine - at road crossing	Determine the impact of the Gold King 7 Level Mine on Cement Creek		37.89397788	-107.6385926
Surface Water	UASW012	CC04	North Fork of Cement Creek upstream of the Gold King 7 Level Mine	Determine background in the North Fork of Cement Creek above Gold King 7 Level	1 of 5 Background Samples	37.89411581	-107.6375422
Surface Water	UASW013	-	Cement Creek upstream of the confluence with the North Fork of Cement Creek	Determine contaminant concentrations in Cement Creek upstream of the confluence with the North Fork of Cement Creek		37.89506486	-107.6472334
Surface Water	UASW014	-	Cement Creek downstream of Red and Bonita Mine	Determine the impact of Red and Bonita Mine on Cement Creek		37.89650119	-107.6466039
Surface Water	UASW015	CC0-3D	Drainage channel adjacent to county road below Red and Bonita	Determine contaminant concentrations at the base of the Red and Bonita piles		37.89682249	-107.6448356
Surface Water	UASW016	CC03B	Cement Creek upstream of Red and Bonita Mine	Determine contaminant concentrations in Cement Creek prior to the addition of Red and Bonita discharge		37.89790585	-107.6458382
Surface Water	UASW017	-	Cement Creek downstream of wetland that channels Mogul Mine drainage	Determine the impact of Mogul Mine drainage on Cement Creek		37.90556671	-107.6436829



**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Surface Water	UASW018	-	Cement Creek upstream of wetland that contains Mogul Mine drainage	Determine contaminant concentrations in Cement Creek upstream of Mogul Mine		37.90855318	-107.6423561
Surface Water	UASW019	-	Mogul Mine drainage (in wetland)	Determine contaminant concentrations in Mogul Mine drainage	Duplicate and MS/MSD	37.90896776	-107.6399511
Surface Water	UASW020	-	Cement Creek upstream of Mogul Mine	Determine contaminant concentrations in Cement Creek upstream of Mogul Mine drainage		37.90990821	-107.6405736
Surface Water	UASW021	-	Cement Creek downstream of Mogul North Mine	Determine the impact of Mogul North Mine on Cement Creek		37.91066604	-107.6346712
Surface Water	UASW022	CC02A	Mogul North Mine discharge	Determine contaminant concentrations in Mogul North Mine discharge		37.91070324	-107.6344121
Surface Water	UASW023	CC01T	Cement Creek upstream of Mogul North Mine and downstream of confluence with Lower Ross	Determine contaminant concentrations in Cement Creek tributary upstream of Mogul North Mine		37.91019522	-107.6333027
Surface Water	UASW024	CC01S	Cement Creek downstream of Queen Anne Mine and upstream of confluence with Lower Ross	Determine contaminant concentrations in Cement Creek downstream of Queen Anne Mine and upstream of Mogul Mine		37.91039194	-107.6330064
Surface Water	UASW029	A72	Animas River Below Silverton			37.79040727	-107.6677567
Surface Water	UASW030	CC01F	Lower Ross Basin Drainage upstream of Grand Mogul Mine	Determine contaminant concentrations in Lower Ross Basin Drainage downstream of Adolphin Mine and upstream of Grand Mogul Mine	1 of 5 Background Samples	37.90926838	-107.6297553
Surface Water	UASW032	-	Animas River downstream of the confluence with Mineral Creek	Determine the impact of Mineral Creek on the Animas River		37.80064343	-107.6681545
Surface Water	UASW033	M34	Mineral Creek upstream of the confluence with the Animas River	Determine contaminant concentrations in Mineral Creek		37.80278383	-107.672785
Surface Water	UASW034	-	Animas River upstream of the confluence with Mineral Creek	Determine contaminant concentrations in the Animas River upstream of the confluence with Mineral Creek		37.80135406	-107.6675203
Surface Water	UASW035	CC48	Cement Creek downstream of the Kendrick-Gelder Smelter	Determine the impact of the Kendrick-Gelder smelter on Cement Creek	Duplicate and MS/MSD	37.81976805	-107.6630793
Surface Water	UASW036	-	Cement Creek upstream of the Kendrick-Gelder Smelter	Determine contaminant concentrations in Cement Creek upstream of Kendrick-Gelder Smelter		37.82414107	-107.6667121
Surface Water	UASW037	-	Cement Creek downstream of the Illinois Gulch drainage	Determine the impact of Illinois Gulch drainage on Cement Creek		37.84895488	-107.6774917
Surface Water	UASW039	-	Cement Creek upstream of the confluence with Illinois Gulch drainage and downstream of Ohio Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Illinois Gulch drainage and downstream of Ohio Gulch drainage		37.85179999	-107.6764859
Surface Water	UASW040	-	Ohio Gulch drainage	Determine contaminant concentrations in Ohio Gulch drainage		37.85201888	-107.6766856
Surface Water	UASW041	-	Cement Creek upstream of the confluence with Ohio Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Ohio Gulch drainage		37.85216376	-107.6765639

**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Surface Water	UASW042	-	Cement Creek downstream of the Anglo Saxon Mine drainage	Determine the impact of Anglo Saxon Mine drainage on Cement Creek		37.85854264	-107.6764944
Surface Water	UASW043	-	Anglo Saxon Mine drainage	Determine contaminant concentrations in Anglo Saxon Mine drainage		37.85900182	-107.6770285
Surface Water	UASW044	-	Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage		37.85940622	-107.6762668
Surface Water	UASW045	-	Minnesota Gulch drainage	Determine contaminant concentrations in Minnesota Gulch drainage	1 of 5 Background Samples	37.86177679	-107.6765537
Surface Water	UASW046	-	Cement Creek upstream of the confluence with Minnesota Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Minnesota Gulch drainage		37.864032	-107.6755015
Surface Water	UASW047	-	Cement Creek downstream of the Elk Tunnel and Fairview Gulch	Determine the impact of the Elk Tunnel and Fairview Gulch on Cement Creek		37.86964659	-107.6746802
Surface Water	UASW049	-	Cement Creek upstream of the confluence with Fairview Gulch and the Elk Tunnel discharge and downstream of Georgia Gulch	Determine contaminant concentrations in Cement Creek upstream of Fairview Gulch and the Elk Tunnel Discharge and downstream of Georgia Gulch		37.87527629	-107.6726218
Surface Water	UASW050	-	Cement Creek upstream of Georgia Gulch and downstream of the Mammoth Tunnel	Determine the impact of the Mammoth Tunnel on Cement Creek		37.87583696	-107.6716351
Surface Water	UASW054	-	Prospect Gulch drainage	Determine contaminant concentrations in Prospect Gulch drainage		37.88252259	-107.6675612
Surface Water	UASW056	-	Cement Creek downstream of the Dry Gulch drainage	Determine the impact of Dry Gulch drainage on Cement Creek		37.885399	-107.6649774
Surface Water	UASW058	-	Cement Creek upstream of the confluence with Dry Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Dry Gulch drainage		37.88656029	-107.6632767
Surface Water/ Aqueous Source	UASW059	CC01C	Discharge from toe of Grand Mogul Mine	Determine contaminant contributions in Grand Mogul Mine Drainage		37.909906	-107.6309876
Surface Water/ Aqueous Source	UAAD001	CC19	American Tunnel discharge (at portal)	Determine contaminant concentrations in American Tunnel Discharge		37.89098103	-107.6484609
Surface Water/ Aqueous Source	UAAD002	CC06	Upper Gold King 7 Level Mine adit discharge	Determine contaminant concentrations in Gold King 7 Level Mine adit Discharge		37.89459073	-107.6383929
Surface Water/ Aqueous Source	UAAD003	CC03C	Red and Bonita Mine adit discharge	Determine contaminant concentrations in Red and Bonita Mine adit Discharge		37.89727185	-107.6438928
Surface Water/ Aqueous Source	UAAD004	CC02D	Mogul Mine adit discharge	Determine contaminant concentrations in Mogul Mine adit Discharge		37.91000846	-107.6382162
Surface Water	UASW097	-	Duplicate Sample and MS/MSD Sample: Dup of UASW035	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.81976805	-107.6630793

**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Surface Water	UASW098	-	Duplicate Sample and MS/MSD Sample: Dup of UASW005	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.88958969	-107.6530445
Surface Water	UASW099	-	Duplicate Sample and MS/MSD Sample: Dup of UASW019	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.90896776	-107.6399511
Sediment	UASE001	-	Animas River downstream of the confluence with Cement Creek	Determine the impact of Cement Creek on the Animas River and the fisheries it supports		37.80955582	-107.6604985
Sediment	UASE002	-	Cement Creek immediately upstream of the confluence with the Animas River	Determine contaminant concentrations in Cement Creek immediately upstream of the confluence with Animas River		37.8097218	-107.6605579
Sediment	UASE003	A68	Animas River upstream of the confluence with Cement Creek	Establish background concentrations in the Animas River	1 of 5 Background Samples	37.8107356	-107.6595997
Sediment	UASE004	-	Cement Creek downstream of the confluence with the South Fork of Cement Creek	Determine the impact of the South Fork of Cement Creek on Cement Creek		37.88922024	-107.6574425
Sediment	UASE005	CC17	South Fork of Cement Creek	Determine contaminant concentrations in South Fork of Cement Creek	1 of 5 Background Samples, Duplicate, and MS/MSD	37.88958969	-107.6530445
Sediment	UASE006	-	Cement Creek downstream of the American Tunnel and upstream of the confluence with the South Fork of Cement Creek	Determine the impact of the American Tunnel discharge on Cement Creek		37.8898256	-107.6531778
Sediment	UASE007	CC18	Discharge from the American Tunnel immediately above confluence with Cement Creek	Determine contaminant concentrations in the American Tunnel Discharge		37.89187922	-107.6486617
Sediment	UASE008	-	Cement Creek upstream of the American Tunnel	Determine contaminant concentrations in Cement Creek upstream of the confluence with the American Tunnel discharge		37.89248894	-107.6484147
Sediment	UASE009	-	Cement Creek downstream of the confluence with the North Fork of Cement Creek	Determine the impact of the North Fork of Cement Creek on Cement Creek		37.89488872	-107.6472536
Sediment	UASE010	-	North Fork of Cement Creek upstream of the confluence with Cement Creek	Determine contaminant concentrations in the North Fork of Cement Creek	This sample was re-collected and labeled UASE060, due to uncertainty if sufficient volume of fines was obtained in initial sample.	37.89086142	-107.6470243
Sediment	UASE011	-	North Fork of Cement Creek downstream of the Gold King 7 Level Mine - at road crossing	Determine the impact of the Gold King 7 Level Mine on Cement Creek		37.89397788	-107.6385926
Sediment	UASE012	-	North Fork of Cement Creek upstream of the Gold King 7 Level Mine	Determine background in the North Fork of Cement Creek above Gold King 7 Level	1 of 5 Background Samples	37.89411581	-107.6375422
Sediment	UASE013	-	Cement Creek upstream of the confluence with the North Fork of Cement Creek	Determine contaminant concentrations in Cement Creek upstream of the confluence with the North Fork of Cement Creek		37.89506486	-107.6472334



**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Sediment	UASE014	-	Cement Creek downstream of Red and Bonita Mine	Determine the impact of Red and Bonita Mine on Cement Creek		37.89650119	-107.6466039
Sediment	UASE015	CC03D	Drainage channel adjacent to county road below Red and Bonita	Determine contaminant concentrations at the base of the Red and Bonita piles		37.89682249	-107.6448356
Sediment	UASE016	CC03B	Cement Creek upstream of Red and Bonita Mine	Determine contaminant concentrations in Cement Creek prior to the addition of Red and Bonita discharge		37.89790585	-107.6458382
Sediment	UASE017	-	Cement Creek downstream of wetland that channels Mogul Mine drainage	Determine the impact of Mogul Mine drainage on Cement Creek		37.90556671	-107.6436829
Sediment	UASE018	-	Cement Creek upstream of wetland that contains Mogul Mine drainage	Determine contaminant concentrations in Cement Creek upstream of Mogul Mine		37.90855318	-107.6423561
Sediment	UASE019	-	Mogul Mine drainage (in wetland)	Determine contaminant concentrations in Mogul Mine drainage	Duplicate and MS/MSD	37.90896776	-107.6399511
Sediment	UASE020	-	Cement Creek upstream of Mogul Mine	Determine contaminant concentrations in Cement Creek upstream of Mogul Mine drainage		37.90990821	-107.6405736
Sediment	UASE021	-	Cement Creek downstream of Mogul North Mine	Determine the impact of Mogul North Mine on Cement Creek		37.91066604	-107.6346712
Sediment	UASE022	CC02A	Mogul North Mine discharge	Determine contaminant concentrations in Mogul North Mine discharge		37.91070324	-107.6344121
Sediment	UASE023	CC01T	Cement Creek upstream of Mogul North Mine and downstream of confluence with Lower Ross	Determine contaminant concentrations in Cement Creek tributary upstream of Mogul North Mine		37.91019522	-107.6333027
Sediment	UASE024	CC01S	Cement Creek downstream of Queen Anne Mine and upstream of confluence with Lower Ross	Determine contaminant concentrations in Cement Creek downstream of Queen Anne Mine and upstream of Mogul Mine		37.91039194	-107.6330064
Sediment	UASE029	A72	Animas River Below Silverton			37.79040727	-107.6677567
Sediment	UASE030	CC01F	Lower Ross Basin Drainage upstream of Grand Mogul Mine	Determine contaminant concentrations in Lower Ross Basin Drainage downstream of Adelphi Mine and upstream of Grand Mogul Mine	1 of 5 Background Samples	37.90926838	-107.6297553
Sediment	UASE032	-	Animas River downstream of the confluence with Mineral Creek	Determine the impact of Mineral Creek on the Animas River		37.80064343	-107.6681545
Sediment	UASE033	M34	Mineral Creek upstream of the confluence with the Animas River	Determine contaminant concentrations in Mineral Creek		37.80278383	-107.672785
Sediment	UASE034	-	Animas River upstream of the confluence with Mineral Creek	Determine contaminant concentrations in the Animas River upstream of the confluence with Mineral Creek		37.80135406	-107.6675203
Sediment	UASE035	CC48	Cement Creek downstream of the Kendrick-Gelder Smelter	Determine the impact of the Kendrick-Gelder smelter on Cement Creek	Duplicate and MS/MSD	37.81976805	-107.6630793
Sediment	UASE036	-	Cement Creek upstream of the Kendrick-Gelder Smelter	Determine contaminant concentrations in Cement Creek upstream of Kendrick-Gelder Smelter		37.82414107	-107.6667121
Sediment	UASE037	-	Cement Creek downstream of the Illinois Gulch drainage	Determine the impact of Illinois Gulch drainage on Cement Creek		37.84895488	-107.6774917

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**TABLE I**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Sediment	UASE039	-	Cement Creek upstream of the confluence with Illinois Gulch drainage and downstream of Ohio Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Illinois Gulch drainage and downstream of Ohio Gulch drainage		37.85179999	-107.6764859
Sediment	UASE040	-	Ohio Gulch drainage	Determine contaminant concentrations in Ohio Gulch drainage		37.85201888	-107.6766856
Sediment	UASE041	-	Cement Creek upstream of the confluence with Ohio Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Ohio Gulch drainage		37.85216376	-107.6765639
Sediment	UASE042	-	Cement Creek downstream of the Anglo Saxon Mine drainage	Determine the impact of Anglo Saxon Mine drainage on Cement Creek		37.85854264	-107.6764944
Sediment	UASE043	-	Anglo Saxon Mine drainage	Determine contaminant concentrations in Anglo Saxon Mine drainage		37.85900182	-107.6770285
Sediment	UASE044	-	Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage		37.85940622	-107.6762668
Sediment	UASE045	-	Minnesota Gulch drainage	Determine contaminant concentrations in Minnesota Gulch drainage	1 of 5 Background Samples	37.86177679	-107.6765537
Sediment	UASE046	-	Cement Creek upstream of the confluence with Minnesota Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Minnesota Gulch drainage		37.864032	-107.6755015
Sediment	UASE047	-	Cement Creek downstream of the Elk Tunnel and Fairview Gulch	Determine the impact of the Elk Tunnel and Fairview Gulch on Cement Creek		37.86964659	-107.6746802
Sediment	UASE049	-	Cement Creek upstream of the confluence with Fairview Gulch and the Elk Tunnel discharge and downstream of Georgia Gulch	Determine contaminant concentrations in Cement Creek upstream of Fairview Gulch and the Elk Tunnel Discharge and downstream of Georgia Gulch		37.87527629	-107.6726218
Sediment	UASE050	-	Cement Creek upstream of Georgia Gulch and downstream of the Mammoth Tunnel	Determine the impact of the Mammoth Tunnel on Cement Creek		37.87583696	-107.6716351
Sediment	UASE054	-	Prospect Gulch drainage	Determine contaminant concentrations in Prospect Gulch drainage		37.88252259	-107.6675612
Sediment	UASE056	-	Cement Creek downstream of the Dry Gulch drainage	Determine the impact of Dry Gulch drainage on Cement Creek		37.885399	-107.6649774
Sediment	UASE058	-	Cement Creek upstream of the confluence with Dry Gulch drainage	Determine contaminant concentrations in Cement Creek upstream of Dry Gulch drainage		37.88656029	-107.6632767
Sediment	UASE059	CCO1C	Cement Creek at the toe of Grand Mogul Mine	Determine contaminant contributions in Grand Mogul Mine Drainage		37.909906	-107.6309876
Sediment	UASE060	-	Re-collect of UASE010: North Fork of Cement Creek upstream of the confluence with Cement Creek	Determine contaminant concentrations in the North Fork of Cement Creek	This sample was collected due to uncertainty if sufficient volume of fines was obtained in initial sample.	37.89086142	-107.6470243
Sediment	UASE097	-	Duplicate Sample and MS/MSD Sample: Dup of UASE035	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.81976805	-107.6630793

**TABLE 1**  
**Sample Locations and Rationale**

Matrix	Sample #	ARSG Sample #	Location	Rationale	Notes	Latitude	Longitude
Sediment	UASE098	-	Duplicate Sample and MS/MSD Sample: Dup of UASE005	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.88958969	-107.6530445
Sediment	UASE099	-	Duplicate Sample and MS/MSD Sample: Dup of UASE019	MS/MSD is collected to test the precision of laboratory analytical methods. Duplicate is collected to document the precision of sample collection procedures and laboratory analysis.		37.90896776	-107.6399511
Soil	UASO001	-	American Tunnel	Characterize source in vicinity of American Tunnel		37.89133065	-107.6486362
Soil	UASO002	-	American Tunnel	Characterize source in vicinity of American Tunnel		37.89117702	-107.6483629
Soil	UASO003	-	Red and Bonita Mine - top pile	Characterize source at Red and Bonita Mine		37.8972027	-107.6440184
Soil	UASO004	-	Red and Bonita Mine - middle pile	Characterize source at Red and Bonita Mine		37.89732528	-107.6443866
Soil	UASO005	-	Red and Bonita Mine - bottom pile	Characterize source at Red and Bonita Mine		37.89746138	-107.6445318
Soil	UASO006	-	Mogul North Mine waste pile	Characterize source at North Mogul Mine		37.91066912	-107.6340085
Soil	UASO007	-	Grand Mogul stope - west side	Characterize source at Grand Mogul Stope		37.91046051	-107.6318807
Soil	UASO008	-	Grand Mogul stope - east side	Characterize source at Grand Mogul Stope		37.91035316	-107.6315761
Soil	UASO009	-	Grand Mogul Mine waste piles - east side	Characterize source at Grand Mogul Mine		37.91001981	-107.6303379
Soil	UASO010	-	Grand Mogul Mine waste piles - center	Characterize source at Grand Mogul Mine		37.90994872	-107.6304505
Soil	UASO011	-	Grand Mogul Mine waste piles - west side	Characterize source at Grand Mogul Mine		37.91005883	-107.6306195
Soil	UASO012	-	Mogul Mine waste piles - west side	Characterize source at Mogul Mine		37.91014558	-107.6388884
Soil	UASO013	-	Mogul Mine waste piles - adjacent to shed	Characterize source at Mogul Mine		37.9099109	-107.6384627
Soil	UASO014	-	Mogul Mine waste piles - east side	Characterize source at Mogul Mine		37.90982638	-107.6385486

ARSG Animas River Stakeholders Group

**TABLE 2**  
**Source Samples – Adit Discharges**  
**(µg/L)**

Field Sample ID: ARSG ID: Location: Analysis:	UAAD001 (CC19) American Tunnel discharge (at portal) Total Metals	UAAD002 (CC06) Upper Gold King 7 Level Mine adit discharge Total Metals	UAAD003 (CC03C) Red and Bonita Mine adit discharge Total Metals	UAAD004 (CC02D) Mogul Mine adit discharge Total Metals	UAAD001 (CC19) American Tunnel discharge (at portal) Dissolved Metals	UAAD002 (CC06) Upper Gold King 7 Level Mine adit discharge Dissolved Metals	UAAD003 (CC03C) Red and Bonita Mine adit discharge Dissolved Metals	UAAD004 (CC02D) Mogul Mine adit discharge Dissolved Metals	UASW059 (CC01C) Toe of Grand Mogul Mine Dissolved Metals (only)
Analytes									
Aluminum	5,520	18,500	4,680	3,330	4,990	18,300	4,620	3,300	13,200
Antimony	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.5 U	2.50 U
Arsenic	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.72 JD	26.9 ★
Barium	50 U	50 U	50 U	50 U	50 U	50 U	50 U	25 U	25.0 U
Beryllium	4.18 D	7.03 D	8.4 D	4.82 D	3.7 D	5.98 D	6.45 D	4.49 D	0.940 J
Cadmium	1.97 JD	54.9 D	53.1 D	55 D	2.02 D	53 D	48.7 D	50.9 D	105
Calcium	457,000	398,000	441,000	212,000	434,000	395,000	442,000	211,000	17,400
Chromium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.5 U	5.46
Cobalt	133 D	79.1 D	97.4 D	22.3 D	136 D	84.4 D	102 D	22.5 D	25.6
Copper	5 U	4,030 D	5 U	15.3 D	5 U	4,210 D	5 U	20.9 D	4,690
Iron	144,000	73,700	102,000	31,900	133,000	71,600	101,000	27,200	46,400
Lead	3.7 D	6.82 D	107 D	271 D	1.12 JD	5.66 D	98.7 D	255 D	33.8
Magnesium	31,600	22,800	28,700	13,200	29,900	22,600	28,600	13,200	12,000
Manganese	44,000	28,000	30,700	28,700	41,700	27,800	30,500	29,100	8,740
Molybdenum	1 U	1 U	1 U	1 U	1 UJ	1 UJ	1.54 JD	1.99 JD	0.500 U
Nickel	46.3 D	31.2 D	38.2 D	6.74 JD	47.8 D	35.4 D	42.6 D	8.3 D	16.4
Potassium	1,790	1,810	1,860	2,040	1,680	1,790	1,840	2,000	362 J
Selenium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.5 U	2.50 U
Silver	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.500 U
Sodium	9,610	5,350	8,730	6,280	9,080	5,260	8,530	6,210	626
Thallium	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.5 U	2.50 U
Vanadium	10 U	10 U	10 U	10 U	10 U	10 U	10 U	5 U	5.00 U
Zinc	19,100	18,700	15,500	31,300	18,100	18,600	15,400	32,700	24,900

µg/L micrograms per liter  
 J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the element is reliable.  
 U The analyte was not detected at or above the CRDL.  
 UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.  
 D The analyte was identified in a sample at a secondary dilution factor.  
 Sources: EPA 2004 (SCDM)

**TABLE 3**  
**Source Samples – Adit Sediments**  
**mg/kg (ppm)**

Field Sample ID: Location:	UAAD001 American Tunnel discharge (at portal)	UAAD002 Upper Gold King 7 Level Mine adit discharge	UAAD003 Red and Bonita Mine adit discharge	UAAD004 Mogul Mine adit discharge	UASE059 Toe of Grand Mogul Mine
Analytes					
Aluminum	5,480	3,170	4,960	2,320	986
Antimony	3.2 UJ	2.9 UJ	5.6 J	3.1 UJ	23.3 J
Arsenic	19.1 J	43.9 J	126 J	49.1 J	969 J+)
Barium	17.4	3.5	21.4	41.3	37.1 J+
Beryllium	1.6 U	1.5 UJ	1.7 UJ	1.5 UJ	3 UJ
Cadmium	1.6 U	1.5 UJ	1.7 UJ	1.5 UJ	3 UJ
Calcium	1,580 U	1,490	1,820	1,530 U	2,980 U
Chromium	3.2 U	2.9 UJ	7.4 J	2.2 J	11.3
Cobalt	1.6 UJ	2.9 UJ	3.4 U	16.6	3 UJ
Copper	20.2	11 J	369 J	32.8 J	235 J+
Iron	359,000	445,000	519,000	462,000	273,000
Lead	115 J	1,740	59.4	419	1,100 J
Magnesium	644	1,460 U	1,680 U	1,530 U	2,980 U
Manganese	280	107 J	130 J	2,110 J	304
Nickel	1.6 U	1.5 UJ	1.7 UJ	1.7 J	3 UJ
Potassium	146 J+	1,460 U	1,680 U	1,530 U	2,980 U
Selenium	7.9 UJ	7.3 UJ	8.4 UJ	7.6 UJ	15 U
Silver	1.6 UJ	1.5 UJ	1.7 UJ	1.5 UJ	13.2 J
Sodium	31.2 J+	1,460 U	1,680 U	1,530 U	2,980 UJ
Thallium	1.6 J+	1.5 UJ	1.7 UJ	1.5 UJ	0.19 J-
Vanadium	45.9	12.4	88	12	57.1
Zinc	282 J	361 J-	63.3 J-	232 J-	524 J

mg/kg milligrams per kilogram

ppm parts per million

J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the element is reliable.

U The analyte was not detected at or above the CRDL.

UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.

J- The associated numerical value is an estimated quantity but the result may be biased low.

J+ The associated numerical value is an estimated quantity but the result may be biased high.

**TABLE 4**  
**Source Samples - Mine Waste**  
**mg/kg (ppm)**

Field Sample ID: Location:	UASO001 American Tunnel	UASO002 American Tunnel	UASO003 Red and Bonita Mine - top pile	UASO004 Red and Bonita Mine - middle pile	UASO005 Red and Bonita Mine - bottom pile	UASO006 Mogul North Mine waste pile	UASO007 Grand Mogul stope - west side	UASO008 Grand Mogul stope - east side	UASO009 Grand Mogul Mine waste piles - east side	UASO010 Grand Mogul Mine waste piles - center	UASO011 Grand Mogul Mine waste piles - west side	UASO012 Mogul Mine waste piles - west side	UASO013 Mogul Mine waste piles - adjacent to shed	UASO014 Mogul Mine waste piles - east side
Aluminum	13,900	12,900	8,780	1,470	2,260	1,130	1,450	2,020	11,200	665	13,000	906	3,270	19,500
Antimony	1.3 UJ	1.2 UJ	1.8 J	1.3 U	12 J	13.5 J	11.7 J	1.1 U	1.1 U	12.2 J	1.1 U	1.1 U	3.6 J	1.2 U
Arsenic	23.7 J	13.5 J	9.1 J+	15.7 J+	29.3 J+	34.9 J+	38.6 J+	90.2 J+	96.8 J+	55.2 J+	32.8 J+	13.6 J+	37.7 J+	31.9 J+
Barium	117	113	105 J+	18.7 J+	68.3 J+	83.8 J+	97.2 J+	72.1 J+	34.9 J+	81.3 J+	46.1 J+	37.1 J+	68.4 J+	154 J+
Beryllium	0.64 UJ	0.6 UJ	0.6 UJ	0.65 UJ	0.78 UJ	0.56 UJ	0.55 UJ	0.57 UJ	0.55 UJ	0.54 UJ	0.54 UJ	0.55 UJ	0.55 UJ	0.79 J+
Cadmium	9.6 J	0.6 UJ	0.63 J	0.65 UJ	35.4 J	5 J	7.6 J	1.1 J	0.55 UJ	40 J	0.7 J	0.55 UJ	9 J	3.7 J
Calcium	5,910	2,080	1,780	648 U	775 U	563 U	551 U	807	1,360	535 U	2,030	554 U	547 U	1,540
Chromium	8.4 J	10 J	4.9	1.8	2.2	1.3	1.1 U	2.3	11.9	1.1 U	10	1.1 U	2.7	9.9
Cobalt	8	6.8	1.3	1	0.78 U	0.56 U	0.55 U	0.88	5.5	0.54 U	4.6	0.55 U	1.5	21.4
Copper	244 J	40.6 J	195 J+	104 J+	286 J+	211 J+	471 J+	111 J+	47.1 J+	4,600 J+	33.1 J+	63.1 J+	285 J+	162 J+
Iron	47,800	36,900	102,000	150,000	308,000	8,170	16,900	21,500	36,000	22,200	25,200	7,700	46,300	55,900
Lead	1,820	241	6,440 J	1,850 J	5,080 J	3,880 J	4,920 J	4,510 J	1,030 J	15,500 J	2,260 J	1,050 J	3,170 J	1,070 J
Magnesium	11,200	10,700	5,600	648 U	775 U	563 U	551 U	950	11,100	535 U	12,700	554 U	1,920	9,940
Manganese	1,180 J	796 J	452	630	136	423	122	852	1,620	177	3,280	135	433	5,570
Nickel	5.8 J	6.6 J	2.3 J	1.3 J	0.78 UJ	0.56 UJ	0.55 UJ	0.74 J	5.3 J	0.54 UJ	5.3 J	0.55 UJ	1.4 J	9.5 J
Potassium	1,070 J+	1,030 J+	790 J	648 U	775 U	714 J+	1,240 J+	1,460 J+	872 J+	1,200 J+	671 J+	961 J+	769 J+	1,090 J+
Selenium	3.2 UJ	3 UJ	3 U	3.2 U	3.9 U	2.8 U	2.8 U	2.8 U	2.8 U	3.4	2.7 U	2.8 U	2.7 U	3 U
Silver	5.4 J	1.3 J	103 J	10.4 J	27.5 J	34.6 J	54 J	8.4 J	5.7 J	113 J	4.6 J	6.9 J	22.9 J	2.7 J
Sodium	640 U	605 U	604 UJ	648 U	775 U	563 UJ	551 UJ	569 UJ	552 UJ	535 UJ	541 UJ	554 UJ	547 UJ	597 UJ
Thallium	0.64 UJ	0.6 UJ	0.5	0.23 J-	0.1 J-	0.61	0.85	1.2	0.36 J-	0.73	0.38 J-	0.43 J-	0.37 J-	0.56
Vanadium	53.6	65.3	26	23.7	49.7	7.8	12	17.5	62.1	7.1	60.8	4.9	15.4	47.5
Zinc	2,610 J-	102 J-	167 J	265 J	11,300 J	1,400 J	2,100 J	319 J	187 J	10,400 J	210 J	140 J	2,580 J	498 J

ng/kg milligrams per kilogram  
 ppm parts per million  
 J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the element is reliable.  
 U The analyte was not detected at or above the CRDL.  
 UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.  
 J- The associated numerical value is an estimated quantity but the result may be biased low.  
 J+ The associated numerical value is an estimated quantity but the result may be biased high.

**TABLE 5**  
**Highest Background Analyte Value Selected from 5 Surface Water Background Locations**  
**Dissolved Metals**  
**µg/L (ppb)**

Field Sample ID: Location:	Highest Selected Background Value	UASW003 (A68) Animas River upstream of confluence with Cement Creek	UASW005 (CC17) South Fork of Cement Creek	UASW012 North Fork of Cement Creek upstream of the Gold King 7 Level Mine	UASW030 (CC01F) Lower Ross Basin Drainage upstream of Grand Mogul Mine	UASW045 Minnesota Gulch Drainage
<b>Analytes</b>						
Aluminum	4,280	86.2	720	3,820	69.0	4,280
Antimony	2.5 U	2.5 U	2.5 U	2.5 U	2.50 U	2.5 U
Arsenic	2.5 U	2.5 U	2.5 U	2.5 U	2.50 U	2.5 U
Barium	30.8	25 U	25 U	25 U	30.8 J	29 J
Beryllium	1.05	0.5 U	0.5 U	0.595 J	0.500 U	1.05
Cadmium	4.69	1.82	2.73	4.69	3.09	3.79
Calcium	162,000	54,300	162,000	52,500	46,200	52,700
Chromium	2.56 J	2.5 U	2.5 U	2.56 J	2.50 U	2.5 U
Cobalt	20.6	0.5 U	7.71	7.94	0.500 U	20.6
Copper	291	2.5 U	8.83	291	25.2	150
Iron	3,230	100 U	3,230	100 U	100 U	268
Lead	9.44	0.79 J	0.643 J	4.50	0.620 J	9.44
Magnesium	9,690	3,290	8,230	7,230	4,060	9,690
Manganese	1,940	1,940	1,840	742	120	1,620
Molybdenum	3.63	3.63	0.535 J	0.5 U	0.500 U	0.5 U
Nickel	13.6	2.5 U	2.5 U	5.44	2.50 U	13.6
Potassium	747 J	614 J	747 J	545 J	294 J	714 J
Selenium	2.5 U	2.5 U	2.5 U	2.5 U	2.50 U	2.5 U
Silver	0.843 J	0.843 J	0.5 U	.50 U	0.500 U	0.5 U
Sodium	3,470	2,460	3,470	2,040	1,230	1,620
Thallium	15.4	15.4	2.5 U	5.00 U	2.50 U	2.5 U
Vanadium	5.0 U	5.0 U	5.0 U	1.00 U	5.00 U	5.0 U
Zinc	924	449	647	924	556	907

J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the analyte is reliable.  
 U The analyte was not detected above the CRQL.  
 µg/L micrograms per liter  
 BOLD Background value

**TABLE 6**  
**Surface Water Dissolved Metals Analytical Summary**  
 Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID: Location:	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW030 (CC01F) Lower Ross Basin Drainage upstream of Grand Mogul Mine (1 of 5 Backgrounds)	UASW024 (CC01S) Drainage from Queen Anne Mine upstream of Lower Ross Basin (source)	UASW023 (CC01T) Cement Creek upstream of Mogul North Mine & downstream of Lower Ross Basin (source)	UASW022 (CC02A) Mogul Mine North Discharge (source)	UASW021 Cement Creek downstream of Mogul North Mine	UASW020 Cement Creek upstream of Mogul Mine	UASW018 Cement Creek upstream of wetland that contains Mogul Mine drainage
Aluminum	750	87	4,280	69.0	2,180	1,580	1,430	1,520	996	2,830
Antimony	-	-	2.5 U	2.50 U	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U
Arsenic	340	150	2.5 U	2.50 U	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U
Barium	-	-	30.8	30.8 J	34.7 J	29.1 J	39.4 J	26.3 J	25.0 U	25.0 U
Beryllium	-	-	1.05	0.500 U	0.968 J	0.500 U	0.5 U	0.649 J	0.500 U	0.760 J
Cadmium	2.0	0.25	4.69	3.09	16.9	13.6	10.9	12.0	8.88	19.2 ★
Calcium	-	-	162,000	46,200	72,700	55,400	62,000	55,900	45,100	71,600
Chromium	-	-	2.56 J	2.50 U	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U
Cobalt	-	-	20.6	0.500 U	0.5 U	0.500 U	0.5 U	0.500 U	0.500 U	3.02
Copper	13	9.0	291	25.2	36.6	102	22.3	105	91.1	240
Iron	-	1,000	3,230	100 U	100 U	100 U	100 U	100 U	100 U	413
Lead	65	2.5	9.44	0.620 J	2.21	2.03	2.54	2.62	4.01	11.9
Magnesium	-	-	9,690	4,060	9,760	7,020	8,310	7,150	5,520	6,880
Manganese	-	-	1,940	120	977	633	111	550	306	4,040
Molybdenum	-	-	3.63	0.500 U	0.5 U	0.500 U	0.5 U	0.500 U	0.500 U	0.500 U
Nickel	470	52	13.6	2.50 U	12.1	6.06	9.47	6.43	4.42 J	5.71
Potassium	-	-	747 J	294 J	561 J	250 J	634 J	517 J	462 J	593 J
Selenium	-	5.0	2.5 U	2.50 U	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U
Silver	180	-	0.843 J	0.500 U	0.5 U	0.500 U	0.5 U	0.500 U	0.500 U	0.500 U
Sodium	-	-	3,470	1,230	1,340	1,280	1,260	1,260	1,150	2,190
Thallium	-	-	15.4	2.50 U	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U
Vanadium	260	-	5.0 U	5.00 U	5 U	5.00 U	5 U	5.00 U	5.00 U	5.00 U
Zinc	120	120	924	556	3,230	2,750	3,080	2,550	1,920	5,950 ★



TABLE 6, cont.  
 Surface Water Dissolved Metals Analytical Summary  
 Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID: Location:	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW019 Wetlands through which Mogul mine drains to Cement Creek (source)	UASW017 Cement Creek downstream of wetland and channels Mogul Mine drainage	UASW016 (OPP12) Cement Creek upstream of Red and Bonita Mine	UASW015 CC03D Drainage from Red & Bonita Mine before the culvert under the road (source)	UASW014 Cement Creek downstream of Red and Bonita Mine	UASW013 Cement Creek upstream of the confluence with the North Fork of Cement Creek	UASW012 North Fork of Cement Creek upstream of Gold King 7 Level Mine (1 of 5 backgrounds)	UASW011 North Fork of Cement Creek downstream of Gold King 7 Level Mine
Aluminum	750	87	4,280	10,100	2,570	2,480	3,040	4,980	3,550	3,320	18,100 *
Antimony	-	-	2.5 U	2.5 U	2.50 U	2.50 U	5 U	2.50 U	2.50 U	2.5 U	5 U
Arsenic	340	150	2.5 U	2.5 U	2.50 U	2.50 U	5 U	2.50 U	2.50 U	2.5 U	5 U
Barium	-	-	30.8	25 U	25.0 U	25.0 U	50 U	25.0 U	25.0 U	25 U	50 U
Beryllium	-	-	1.05	3.8	1.08	0.500 U	6.95	3.03	2.73	0.595 J	7.06 ☆
Cadmium	2.0	0.25	4.69	72.8	15.8 ★	13.7	42.2	25.8 ★	22.0 ★	4.69	53.3 ★
Calcium	-	-	162,000	174,000	81,400	87,800	450,000	231,000	210,000	52,500	388,000
Chromium	-	-	2.56 J	2.5 U	2.50 U	2.50 U	5 U	2.50 U	2.50 U	2.56 J	5 U
Cobalt	-	-	20.6	22.6	2.34	1.83	95.9	46.0	36.3	7.94	81.4 ☆
Copper	13	9.0	291	820	201	140	5 U	121	128	291	4,580 ★
Iron	-	1,000	3,230	4,460	186 J	210 J	95,200	30,600 ★	27,700 ★	100 U	66,700 ★
Lead	65	2.5	9.44	75.6	12.6	7.42	13.1	16.1	13.3	4.5	5.66
Magnesium	-	-	9,690	13,600	6,280	6,010	28,900	15,700	14,000	7,230	22,300
Manganese	-	-	1,940	21,900	3,370	3,000	31,900	14,900 ★	12,800 ☆	742	26,000 ☆
Molybdenum	-	-	3.63	0.5 U	0.500 U	0.500 U	1 U	0.500 U	0.500 U	0.5 U	1 U
Nickel	470	52	13.6	13.6	4.23 J	3.23 J	38.6	20.2	16.3	5.44	35.8
Potassium	-	-	747 J	1,420	568 J	532 J	1,850	920 J	874 J	545 J	1,790
Selenium	-	5.0	2.5 U	2.5 U	2.50 U	2.50 U	5 U	2.50 U	2.50 U	2.5 U	5 U
Silver	180	-	0.843 J	0.5 U	0.500 U	0.500 U	1 U	0.500 U	0.500 U	0.5 U	1 U
Sodium	-	-	3,470	5,520	2,610	2,890	8,800	5,430	4,980	2,040	5,240
Thallium	-	-	15.4	2.5 U	2.50 U	2.50 U	5 U	2.50 U	2.50 U	2.5 U	5 U
Vanadium	260	-	5.0 U	5 U	5.00 U	5.00 U	10 U	5.00 U	5.00 U	5 U	10 U
Zinc	120	120	924	27,600	4,910 ★	4,640 ★	15,500	8,770 ★	7,890 ★	924	17,100 ★

**TABLE 6, cont.**  
**Surface Water Dissolved Metals Analytical Summary**  
 Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID:	Location:	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW010 North Fork of Cement Creek upstream of confluence with Cement Creek	UASW009 Cement Creek downstream of the confluence with the North Fork of Cement Creek	UASW008 Cement Creek upstream of the American Tunnel	UASW007 (CC18) Discharge from American Tunnel immediately above confluence with Cement Creek (source)	UASW006 Cement Creek downstream of the American Tunnel and upstream of the confluence with the South Fork of Cement Creek	UASW005 (CC17) South Fork of Cement Creek (1 of 5 backgrounds)	UASW004 Cement Creek downstream of confluence with the South Fork of Cement Creek	UASW058 Cement Creek upstream of the confluence with Dry Gulch drainage
Analytes												
Aluminum		750	87	4,280	23,500 ★	7,030	7,940	5,730	9,160	720	5,130	5,510 ★
Antimony		-	-	2.5 U	5 U	2.50 U	2.50 U	5 U	2.50 U	2.5 U	2.50 U	2.50 U
Arsenic		340	150	2.5 U	5 U	2.50 U	2.50 U	5 U	2.50 U	2.5 U	2.50 U	2.50 U
Barium		-	-	30.8	50 U	25.0 U	25.0 U	50 U	25.0 U	25 U	25.0 U	25.0 U
Beryllium		-	-	1.05	6.34 ☆	3.57 ☆	2.88	3.54	3.61 ☆	0.5 U	2.28	1.52
Cadmium		2.0	0.25	4.69	63.7 ★	29.1 ★	28.7 ★	2.54	30.3 ★	2.73	16.1 ★	13.7
Calcium		-	-	162,000	348,000	230,000	238,000	450,000	258,000	162,000	202,000	182,000
Chromium		-	-	2.56 J	5 U	2.50 U	2.50 U	5 U	2.50 U	2.5 U	2.50 U	2.50 U
Cobalt		-	-	20.6	83.1 ☆	49.2	46.6	136	59.4	7.71	33.0	30.4
Copper		13	9.0	291	4,230 ★	909 ★	884 ★	5 U	796	8.83	398	366
Iron		-	1,000	3,230	52,900 ★	31,400 ★	30,000 ★	131,000	32,500 ★	3,230	16,200 ★	15,900 ★
Lead		65	2.5	9.44	5.93	14.6	19.3	1.52 J	44.8 ★	0.643 J	25.0	27.9
Magnesium		-	-	9,690	24,800	15,600	16,100	31,400	18,200	8,230	13,100	12,600
Manganese		-	-	1,940	23,700 ☆	14,800 ☆	14,800 ☆	43,000	18,500 ☆	1,840	10,100 ☆	9,150 ☆
Molybdenum		-	-	3.63	1 U	0.500 U	0.500 U	1 U	0.500 U	0.535 J	0.500 U	0.500 U
Nickel		470	52	13.6	39.3	328 ★	20.8	46.9	24.8	2.5 U	14.7	12.6
Potassium		-	-	747 J	1,430	899 J	926 J	1,740	987 J	747 J	933 J	1,070
Selenium		-	5.0	2.5 U	5 U	2.50 U	2.50 U	5 U	2.50 U	2.5 U	2.50 U	2.50 U
Silver		180	-	0.843 J	1 U	0.500 U	0.500 U	1 U	0.500 U	0.5 U	0.500 U	0.500 U
Sodium		-	-	3,470	5,140	4,820	5,100	9,500	5,630	3,470	4,480	4,370
Thallium		-	-	15.4	5 U	2.50 U	2.50 U	5 U	2.50 U	2.5 U	2.50 U	2.50 U
Vanadium		260	-	5.0 U	10 U	5.00 U	5.00 U	10 U	5.00 U	5 U	5.00 U	5.00 U
Zinc		120	120	924	16,200 ★	9,350 ★	9,230 ★	18,800	10,700 ★	647	5,510 ★	5,130 ★

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**TABLE 6, cont.**  
**Surface Water Dissolved Metals Analytical Summary**  
 Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID: Location:	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW056 Cement Creek downstream of the Dry Gulch drainage	UASW054 Prospect Gulch drainage  (source)	UASW050 Cement Creek downstream of the Mammoth Tunnel	UASW049 Cement Creek upstream of the confluence with Fairview Gulch and the Elk Tunnel discharge	UASW047 Cement Creek downstream of the Elk Tunnel and Fairview Gulch	UASW046 Cement Creek upstream of the confluence with Minnesota Gulch drainage	UASW045 Minnesota Gulch drainage  (1 of 5 backgrounds)	UASW044 Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage
Aluminum	750	87	4,280	5,440	14,400	8,830	8,900	8,450	8,340	4,280	8,150
Antimony	-	-	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.5 U	2.50 U
Arsenic	340	150	2.5 U	2.50 U	17	4.63 J	5.00 J	3.51 J	2.50 U	2.5 U	2.50 U
Barium	-	-	30.8	25.0 U	25 U	25.0 U	25.0 U	25.0 U	25.0 U	29 J	25.0 U
Beryllium	-	-	1.05	1.75	0.726 J	1.50	1.27	1.44	1.52	1.05	1.32
Cadmium	2.0	0.25	4.69	12.7	5.33	9.70	9.51	8.99	8.60	3.79	9.09
Calcium	-	-	162,000	178,000	35,400	169,000	171,000	170,000	170,000	52,700	167,000
Chromium	-	-	2.56 J	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.5 U	2.50 U
Cobalt	-	-	20.6	30.4	26.1	28.7	29.8	29.4	28.2	20.6	28.9
Copper	13	9.0	291	355	190	235	239	225	212	150	212
Iron	-	1,000	3,230	16,000 ★	27,600	23,900 ★	24,100 ★	21,800 ★	20,000 ★	2.68	18,200 ★
Lead	65	2.5	9.44	26.8	57.3	25.3	25.4	24.7	24.8	9.44	26.0
Magnesium	-	-	9,690	12,200	7,560	11,700	11,800	11,400	11,300	9,690	11,200
Manganese	-	-	1,940	8,750 ★	826	6,240 ★	6,180 ★	5,860 ★	5,780	1,620	5,750
Molybdenum	-	-	3.63	0.500 U	0.5 U	0.500 U	0.500 U	0.500 U	0.500 U	0.5 U	0.500 U
Nickel	470	52	13.6	12.2	19.6	15.2	15.3	14.4	13.2	13.6	14.9
Potassium	-	-	747 J	1,100	2,130	1,700	1,720	1,680	1,660	714 J	1,650
Selenium	-	5.0	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.5 U	2.50 U
Silver	180	-	0.843 J	0.500 U	0.5 U	0.500 U	0.500 U	0.500 U	0.500 U	0.5 U	0.500 U
Sodium	-	-	3,470	4,280	1,230	3,810	3,870	3,990	4,030	1,620	4,030
Thallium	-	-	15.4	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.5 U	2.50 U
Vanadium	260	-	5.0 U	5.00 U	5 U	5.00 U	5.00 U	5.00 U	5.00 U	5 U	5.00 U
Zinc	120	120	924	4,850 ★	1,350	3,560 ★	3,510 ★	3,320 ★	3,230 ★	907	3,210 ★

TABLE 6, cont.  
Surface Water Dissolved Metals Analytical Summary  
Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID:	Location:	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW043 Anglo Saxon Mine drainage  (source)	UASW042 Cement Creek downstream of the Anglo Saxon Mine drainage	UASW041 Cement Creek upstream of the confluence with Ohio Gulch drainage	UASW040 Ohio Gulch drainage  (source)	UASW039 Cement Creek upstream of the Illinois Gulch drainage and downstream of Ohio Gulch drainage	UASW037 Cement Creek downstream of the Illinois Gulch drainage	UASW036 Cement Creek upstream of the Kendrick-Gelder Smelter	UASW035 (CCS*) Cement Creek downstream of the Kendrick-Gelder Smelter
Aluminum		750	87	4,280	225	7,870	8,090	17,100	8,320	7,580	7,800	7,890
Antimony		-	-	2.5 U	5 U	2.50 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U
Arsenic		340	150	2.5 U	5 U	2.50 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U
Barium		-	-	30.8	50 U	25.0 U	25.0 U	25 U	25.0 U	25.0 U	25.0 U	25.0 U
Beryllium		-	-	1.05	1.31 J	1.36	1.58	1.72	0.925 J	0.986 J	0.910 J	1.14
Cadmium		2.0	0.25	4.69	2.1	8.14	8.71	4.41	7.47	7.38	5.87	6.57
Calcium		-	-	162,000	304,000	175,000	171,000	57,800	165,000	172,000	171,000	177,000
Chromium		-	-	2.56 J	5 U	2.50 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U
Cobalt		-	-	20.6	34.9	25.6	26.7	59.1	27.3	24.7	23.5	22.3
Copper		13	9.0	291	5 U	191	184	229	184	175	146	147
Iron		-	1,000	3,230	19,300	17,100 ★	17,200 ★	32,700	17,600 ★	14,800 ★	12,200 ★	12,000 ★
Lead		65	2.5	9.44	1 U	24.1	24.5	95.6	25.7	22.4	18.9	17.4
Magnesium		-	-	9,690	18,900	11,600	11,300	12,600	11,300	10,900	10,600	10,900
Manganese		-	-	1,940	8,020	5,900 ★	5,710	5,010	5,610	5,280	4,390	4,580
Molybdenum		-	-	3.63	1 U	0.500 U	0.500 U	0.5 U	0.500 U	0.557 J	0.900 U	0.500 U
Nickel		470	52	13.6	5 U	12.2	12.9	33.2	12.7	11.5	11.7	11.0
Potassium		-	-	747 J	2,450	1,650	1,680	1,300	1,680	1,580	1,780	1,840
Selenium		-	5.0	2.5 U	5 U	2.50 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U
Silver		180	-	0.843 J	1 U	0.500 U	0.500 U	0.5 U	0.500 U	0.500 U	0.891 J	0.500 U
Sodium		-	-	3,470	9,620	4,280	4,150	2,180	4,090	4,310	4,460	4,550
Thallium		-	-	15.4	5 U	2.50 U	2.50 U	2.5 U	2.77 J	4.02 J	6.35	2.50 U
Vanadium		260	-	5.0 U	10 U	5.00 U	5.00 U	5 U	5.00 U	5.00 U	5.00 U	5.00 U
Zinc		120	120	924	2,450	3,160 ★	3,090 ★	1,070	3,000 ★	2,800 ★	2,260	2,340

TABLE 6, cont.  
 Surface Water Dissolved Metals Analytical Summary  
 Concentrations in micrograms per liter (µg/L) parts per billion (ppb)

Field Sample ID: Location: Analytes	Superfund Chemical Data Matrix (SCDM) Environmental Acute (µg/L)	Superfund Chemical Data Matrix (SCDM) Environmental Chronic (µg/L)	Highest Selected Background Value (from Table 5)	UASW02 Cement Creek immediately upstream of the confluence with the Animas River	UASW003 (A65) Animas River upstream of confluence with Cement Creek (1 of 5 backgrounds)	UASW01 Animas River downstream of confluence with Cement Creek	UASW34 Animas River upstream of confluence with Mineral Creek	UASW033 (M34) Mineral Creek upstream of confluence with the Animas river (source)	UASW32 Animas River downstream of confluence with Mineral Creek	UASW29 (A72) Animas River most downstream sample location
Aluminum	750	87	4,280	7,810	86.2	7,330	530	381	275	1,300
Antimony	-	-	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.50 U
Arsenic	340	150	2.5 U	2.50 U	2.5 U	2.50 U	2.50 U	2.50 U	2.50 U	2.50 U
Barium	-	-	30.8	25.0 U	25 U	25.0 U	25.0 U	25.0 U	25.0 U	25.0 U
Beryllium	-	-	1.05	0.826 J	0.5 U	1.17	0.5 U	0.5 U	0.5 U	0.5 U
Cadmium	2.0	0.25	4.69	6.55	1.82	6.19	2.96	0.926 J	1.76	0.653 J
Calcium	-	-	162,000	175,000	54,300	169,000	91,000	57,500	76,900	87,500
Chromium	-	-	2.56 J	2.5 U	2.5 U	2.50 U	2.5 U	2.5 U	2.50 U	2.50 U
Cobalt	-	-	20.6	23.7	0.5 U	20.4	7.33	3.75	6.34	3.84
Copper	13	9.0	291	148	2.5 U	121	26.1	2.5 U	13.9	2.50 U
Iron	-	1,000	3,230	11,500 ★	100 U	10,800 ★	1,980	2,800	2,630	8,140
Lead	65	2.5	9.44	17.8	0.79 J	17.8	0.5 U	1.23	0.5 U	8.74
Magnesium	-	-	9,690	10,900	3,290	10,400	5,630	4,860	5,720	7,330
Manganese	-	-	1,940	4,650	1,940	4,760	2,560	327	1,270	796
Molybdenum	-	-	3.63	1.04 J	3.63	0.500 U	0.67 J	0.5 U	0.500U	0.500 U
Nickel	470	52	13.6	10.6	2.5 U	8.46	2.96 J	2.5 U	2.50 U	2.50 U
Potassium	-	-	747 J	1,790	614 J	1,700	1,010	629 J	856 J	1,620
Selenium	-	5.0	2.5 U	2.50	2.5 U	2.50 U	2.50 U	2.5 U	2.50 U	2.5 U
Silver	180	-	0.843 J	0.953 J	0.843 J	0.5 U	0.500 U	0.5 U	0.500 U	0.500 U
Sodium	-	-	3,470	4,540	2,460	4,450	3,150	3,300	3,570	5,580
Thallium	-	-	15.4	5.61	15.4	2.50 U	2.50 U	2.5 U	2.50 U	2.50 U
Vanadium	260	-	5.0 U	5.00 U	5 U	5.00 U	5.00 U	5 U	5.00 U	5.00 U
Zinc	120	120	924	2,370	449	2,410	1,030	185	558	94.6

J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the analyte is reliable.  
 U The analyte was not detected above the CRQL.  
 µg/L micrograms per liter  
 BOLD Background value  
 J Elevated Concentration (concentration is > 3X background, but not > than a benchmark)  
 ★ Elevated Concentration (concentration is > 3X background and > than a benchmark)

Sources: EPA 2008 (CLP limits); EPA 2004 (SCDM); EPA 2008 (Low Concentration Detection Limits)

**TABLE 7**  
**Highest Background Analyte Value for Total Metals Selected from five Sediment Background Locations**  
**mg/kg (ppm)**

Field Sample ID: Location:	Highest Selected Background Value	UASE003 (A68) Animas River upstream of confluence with Cement Creek	UASE005 (CC17) South Fork of Cement Creek	UASE012 North Fork of Cement Creek upstream of the Gold King 7 Level Mine	UASE030 (CC01F) Lower Ross Basin Drainage upstream of Grand Mogul Mine	UASE045 Minnesota Gulch Drainage
<b>Analytes</b>						
Aluminum	15,700	8,570	8,370	10,900	15,700	10,400
Antimony	1.4 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.2 U	1.4 UJ
Arsenic	(81.6)	5.9 J (10.3)	11.6 J (20.2)	17.3 J (30.1)	31.5 J+	46.9 J (81.6)
Barium	(1253)	108 J (430.9)	78.8	102	94.2 J+	314 J (1253)
Beryllium	1.4 J+	1 J+	0.66 J+	0.63 U	1.4 J+	0.96 J+
Cadmium	(14.7)	5.8 J (8.2)	0.64 UJ	0.63 U	10.4 J (14.7)	0.68 U
Calcium	2,560	2,560	1,230	1,890	1,990	1,350
Chromium	8	6.5	6.2 J (8.0)	8	8	7.8
Cobalt	20.5	10.9 J (13.6)	6.5	10.4	20.5	14.8 J (18.5)
Copper	1,240 J+	119 J (145.2)	65 J (79.3)	73.1	1,240 J+	77.1 J (94.1)
Iron	71,200	20,800	34,800	37,100	71,200	37,000
Lead	(2131)	612	145	532 J (766)	1,480 J (2131)	342
Magnesium	11,500	5,610	1,460	5,380	11,500	3,850
Manganese	6,750	6,750	839 J (1040)	675	6,600	1,560
Nickel	15.8	8.2 J (11.1)	4.2 J (5.67)	7.1	11.7 J (15.8)	7.5 J (10.1)
Potassium	1,310 J+	745 J+	902 J+	1,000 J+	642 J+	1,310 J+
Selenium	(2.6)	0.099 J (0.24)	3.2 UJ	3.1 UJ	3 U	1.1 J (2.6)
Silver	(2.09)	1.5 J+	0.64 UJ	1.3 J+	1.2 J (2.09)	1.5 J+
Sodium	99.3 J+	641 U	640 U	99.3 J+	600 UJ	684 U
Thallium	(0.82)	0.64 U	0.64 UJ	0.35 J+	0.44 J- (0.82)	0.75 J+
Vanadium	52.2	30.6	52.2	49	40.9	48.6
Zinc	(2,250)	1,470 J (2,205)	145 J- (217.5)	73.8 J (110.7)	1,500 J (2,250)	144 J (216)

J- The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the analyte is reliable.  
 J+ The associated numerical value is an estimated quantity but the result may be biased low.  
 J The associated numerical value is an estimated quantity, but the result may be biased high.  
 U The analyte was not detected above the CRQL.  
 UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.  
 mg/kg milligrams/kilogram  
 BOLD Background value  
 (XX) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".

**TABLE 8**  
**Sediment Sample Results - Total Metals**  
**mg/kg (ppm)**

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE001 Animas River downstream of the confluence with Cement Creek	UASE002 Cement Creek immediately upstream of the confluence with the Animas River	UASE003 Animas River upstream of confluence with Cement Creek  (1 of 5 backgrounds)	UASE004 Cement Creek downstream of the confluence with the South Fork of Cement Creek	USSE005 South Fork of Cement Creek  (1 of 5 backgrounds)	UASE006 Cement Creek downstream of the American Tunnel and upstream of the confluence with the South Fork of Cement Creek	UASE007 Discharge from the American Tunnel immediately above confluence with Cement Creek  (source)	UASE008 Cement Creek upstream of the American Tunnel
Aluminum	15,700	6,860	7,030	8,570	9,570	8,370	7,030	13,400	13,700
Antimony	1.4 UJ	2.1 UJ	1.4 UJ	1.3 UJ	1.3 UJ	1.3 UJ	2.8 J (1.4)	5 UJ	1.7 UJ
Arsenic	(81.6)	45.3 J (26.0)	34.1 J (19.6)	5.9 J (10.3)	20.3 J (11.7)	11.6 J (20.2)	50.2 J (28.9)	17.7 J	33.3 J (19.1)
Barium	(1253)	559 J (140)	210 J (52.6)	108 J (430.9)	97.3	78.8	146	24.9 UJ	92.7
Beryllium	1.4 J+	1 UJ	0.72 U	1 J+	0.65 U	0.66 J+	0.95 U	2.5 U	1.1 J+ (0.86)
Cadmium	(14.7)	1 UJ	0.72 U	5.8 J (8.2)	0.9	0.64 UJ	2.9	2.5 U	1.3 J (0.92)
Calcium	2,560	1,100	1,010	2,560	1,530	1,230	1,420	2,490 U	1,660
Chromium	8	6.6	6.4	6.5	7	6.2 J (8.0)	8.4	5 U	7.6 J (5.9)
Cobalt	20.5	3.9 J (2.9)	4.3 J (3.4)	10.9 J (13.6)	11.8	6.5	3.9	2.5 U	16.5
Copper	1,240 J+	48.7 J (39.9)	53 J (43.4)	119 J (145.2)	86.5	65 J (79.3)	279	28.1	209 J (171)
Iron	71,200	78,100	68,800	20,800	57,600	34,800	114,000	238,000 ☆	37,300
Lead	(2131)	459	322	612	726 J (504)	145	5,720 J (3972)	217 J	711
Magnesium	11,500	3,030	4,080	5,610	6,070	1,460	3,810	913	8,730
Manganese	6,750	333	506	6,750	1,530	839 J (1040)	1,340	336	4,130 J (3,331)
Nickel	15.8	3.4 J (2.5)	4 J	8.2 J (11.1)	4.4	4.2 J (5.67)	3.8	1.3	8 J (5.9)
Potassium	1,310 J+	1,700 J+ (97.2)	889 J+ (50.8)	745 J+ (42.6)	751 J+ (42.9)	902 J+	1,560 J+ (89.2)	231 J+	825 U
Selenium	(2.6)	1.6 J (0.67)	0.81 J (0.34)	0.099 J (0.24)	3.3 UJ	3.2 UJ	4.8 UJ	12.4 UJ	4.1 UJ
Silver	(2.09)	4.5 J+ (2.6)	2.5 J+ (1.4)	1.5 J+	1.7 J+ (0.97)	0.64 UJ	12.1 J+ (6.95) ☆	2.5 UJ	2.1 J (1.2)
Sodium	99.3 J+	1,040 U	723 U	641 U	62.3 J+ (2.45)	640 U	118 J+ (4.64)	44.5 J+	825 U
Thallium	(0.82)	1 U	0.72 U	0.64 U	0.39 J+ (0.21)	0.64 UJ	0.6 J+ (0.32)	2.5 UJ	0.83 UJ
Vanadium	52.2	49.7	44.8	50.6	47.3	52.2	47.7	41.8	64.1
Zinc	(2,250)	205 J (137)	199 J (133)	1,470 J (2,205)	261 J (174)	145 J- (217.5)	815 J (543)	269 J	289 J-

J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the analyte is reliable.  
 J- The associated numerical value is an estimated quantity but the result may be biased low.  
 J+ The associated numerical value is an estimated quantity, but the result may be biased high.  
 U The analyte was not detected above the CRQL.  
 UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.  
 mg/kg milligrams/kilogram  
 BOLD Background value  
 (X.X) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
 ☆ Concentration elevated 3X background

000071

TABLE 8, cont.  
Sediment Sample Results-Total Metals  
mg/kg (ppm)

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE009 Cement Creek downstream of the confluence with the North Fork of Cement Creek	UASE010 North Fork of Cement Creek upstream of the confluence with Cement Creek	UASE011 North Fork of Cement Creek downstream of the Gold King 7 Level Mine - at road crossing	UASE012 North Fork of Cement Creek upstream of the Gold King 7 Level Mine (1 of 5 backgrounds)	UASE013 Cement Creek upstream of the confluence with the North Fork of Cement Creek	UASE014 Cement Creek downstream of Red and Bonita Mine	UASE015 Drainage channel adjacent to county road below Red and Bonita (source)	UASE016 Cement Creek upstream of Red and Bonita Mine
Aluminum	15,700	4,940	9,330	2,020	10,900	4,520	3,850	4,670	8,140
Antimony	1.4 UJ	2.7 UJ	1.3 UJ	2.8 UJ	1.3 UJ	2.8 UJ	3 UJ	2.3 J	3.2 UJ
Arsenic	(81.6)	15.2 J (8.7)	26.2 J (15.1)	36.7 J (21.1)	17.3 J (30.1)	20.5 J (11.8)	24.5 J (14.1)	23.2 J	57.5 J (33.0)
Barium	(1253)	71.6	51.8	30.7	102	61.9	36.1	46.5	200
Beryllium	1.4 J+	1.4 UJ	0.64 UJ	1.4 UJ	0.63 U	1.4 UJ	1.5 UJ	1.1 UJ	1.6 UJ
Cadmium	(14.7)	1.4 UJ	0.64 UJ	0.11	0.63 U	1.4 UJ	1.5 UJ	2.4 J	1.6 UJ
Calcium	2,560	1,370 U	1,710	1,380 U	1,890	1,410 U	1,500 U	1,130	1,940
Chromium	8	6.4 J (5.0)	9.1 J (7.1)	5.1 J (4.0)	8	4.3 J (3.3)	6.1 J (4.7)	4 J	11.9 J (9.2)
Cobalt	20.5	6.8	4.3	2.8 U	10.4	6	3 U	2.2 U	23.7
Copper	1,240 J+	124 J (101.6)	42.8 J (35.1)	113 J (92.6)	73.1	84 J (68.9)	147 J (120.5)	112 J	250 J (205)
Iron	71,200	159,000	18,200	397,000 *	37,100	203,000	218,000 *	442,000	65,400
Lead	(2131)	341	294	136	532 J (766)	362	773	457	1,460
Magnesium	11,500	1,370 U	8,680	1,380 U	5,380	1,410 U	1,500 U	1,120 U	2,260
Manganese	6,750	2,010 J (1,621)	624 J (503)	156 J (126)	675	1,910 J (1,537)	489 J (394)	239 J	2,360 J (1,903)
Nickel	15.8	2.2 J (1.6)	4.1 J (3.0)	1.4 UJ	7.1	1.6 J (1.2)	2 J (1.5)	1.1 UJ	12.3 J (9.1)
Potassium	1,310 J+	1,370 U	638 U	1,380 U	1,000 J+	1,410 U	1,500 U	1,120 U	1,580 U
Selenium	(2.6)	6.9 UJ	3.2 UJ	6.9 UJ	3.1 UJ	7.1 UJ	7.5 UJ	5.6 UJ	7.9 UJ
Silver	(2.09)	4 J (2.3)	0.88 J (0.51)	1.4 UJ	1.3 J+	2.3 J (1.32)	8.5 J (4.9)	3.9 J	1.6 UJ
Sodium	99.3 J+	1,370 U	638 U	1,380 U	99.3 J+	1,410 U	1,500 U	1,120 U	1,580 U
Thallium	(0.82)	1.4 UJ	0.64 UJ	1.4 UJ	0.35 J+	1.4 UJ	1.5 UJ	1.1 UJ	1.6 UJ
Vanadium	52.2	27.3	29.1	27.8	49	29.7	34	31.7	62
Zinc	(2,250)	242 J-	145 J-	44.1 J-	73.8 J (110.7)	240 J-	465 J-	1,040 J-	378 J-

J The associated numerical value is an estimated quantity because quality control criteria were not met. Presence of the analyte is reliable.  
J- The associated numerical value is an estimated quantity but the result may be biased low.  
J+ The associated numerical value is an estimated quantity, but the result may be biased high.  
U The analyte was not detected above the CRQL.  
UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present in the sample.  
mg/kg milligrams/kilogram  
BOLD Background value  
(X.X) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
\* Concentration elevated 5X background

000072



TABLE 8, cont.  
 Sediment Sample Results - Total Metals  
 mg/kg (ppm)

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE017 Cement Creek downstream of wetland that channels Mogul Mine drainage	UASE018 Cement Creek upstream of wetland that contains Mogul Mine drainage	UASE019 Mogul Mine drainage (in wetland)	UASE020 Cement Creek upstream of Mogul Mine	UASE021 Cement Creek downstream of Mogul North Mine	UASE022 Mogul North Mine discharge	UASE023 Cement Creek upstream of Mogul North Mine and downstream of confluence with Lower Ross	UASE024 Cement Creek downstream of Queen Anne Mine and upstream of confluence with Lower Ross
Analytes				(source)			(source)		(source)
Aluminum	15,700	8,100	13,100	5,960	12,200	13,600	6,720	3,020	11,500
Antimony	1.4 UJ	1.3 UJ	1.3 UJ	1.6 UJ	1.4 UJ	1.3 U	6.8 U	1.7 J (0.9)	1.7 U
Arsenic	(81.6)	17.7 J (10.2)	28.1 J (16.1)	62.5 J	36.8 J (21.1)	25.8 J+ (14.8)	42.6 J+	45.6 J+ (26.2)	49.4 J+
Barium	(1253)	121	90.8	121	147	74.3 J+ (18.6)	119 J+	264 J+ (66.2)	205 J+
Beryllium	1.4 J+	0.63 U	0.73 J+ (0.57)	0.8 U	1.4 J+ (1.1)	1.3 J+ (1.02)	3.4 UJ	1.3 J+ (1.02)	1.3 J+
Cadmium	(14.7)	0.63 U	2	1.4	7.4	6 J (4.3)	3.4 UJ	6 J (4.3)	7 J
Calcium	2,560	1,740	2,020	804 U	1,110	1,310	3,380 U	718 U	1,280
Chromium	8	6.9	9	8.5	9.6	7.1	19.7	6.2	8.2
Cobalt	20.5	13.2	11.2	5.4	12.9	12.3	4.8	15.3	15.8
Copper	1,240 J+	63.6	193	177	546	516 J+ (423)	303 J+	424 J+ (348)	294 J+
Iron	71,200	38,100	35,000	116,000	31,900	37,200	141,000	5,150	27,100
Lead	(2131)	379 J (263)	543 J (377)	546 J	779 J (541)	481 J (334)	668 J	2,030 J (1409)	754 J
Magnesium	11,500	5,830	8,970	3,260	5,340	7,200	3,380 U	1,090	5,670
Manganese	6,750	1,420	3,650	1,130	5,130	4,710	1,180	7,960	11,500
Nickel	15.8	6.3	5.2	4.5	6.9	10.3 J	5.9 J	7.7 J (5.7)	7.8 J
Potassium	1,310 J+	440 J+ (25.1)	501 J+ (28.6)	842 J+	648 J+ (37.0)	664 U	3,380 U	718 U	1,210 J+
Selenium	(2.6)	3.1 UJ	3.3 UJ	4 UJ	3.5 UJ	3.3 U	17 U	3.6 U	4.3 U
Silver	(2.09)	1.3 J+ (0.75)	1.7 J+ (0.97)	5.1 J+	2.8 J+ (1.61)	2 J (1.15)	27.1 J	11.8 J *	4 J
Sodium	99.3 J+	30.8 J+ (1.2)	21.9 J+ (0.86)	65.3 J+	29.5 J+ (1.16)	664 UJ	3,380 U	718 UJ	855 UJ
Thallium	(0.82)	0.3 J+ (0.16)	0.4 J+ (0.22)	0.3 J+	0.4 J+ (0.22)	0.41 J- (0.22)	0.31 J-	0.77	0.88
Vanadium	52.2	46.3	32.2	42.6	33.2	32.5	20.8	27.8	38
Zinc	(2,250)	184 J (123)	332 J (221)	444 J	1,990 J (1327)	651 J (434)	350 J	614 J (409)	899 J

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 mg/kg milligrams/kilogram  
 BOLD Background value  
 (X.X) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
 ☆ Concentration elevated 3X background

TABLE 8, cont.  
 Sediment Sample Results - Total Metals  
 mg/kg (ppm)

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE029 Animas River Below Silverton	UASE030 Lower Ross Basin Drainage upstream of Grand Mogul Mine (1 of 5 backgrounds)	UASE032 Animas River downstream of the confluence with Mineral Creek	UASE033 Mineral Creek upstream of the confluence with the Animas River (source)	UASE034 Animas River upstream of the confluence with Mineral Creek	UASE035 Cement Creek downstream of the Kendrick-Gelder Smelter	UASE036 Cement Creek upstream of the Kendrick-Gelder Smelter	UASE037 Cement Creek downstream of the Illinois Gulch drainage
Aluminum	15,700	12,300	15,700	8,000	28,200	11,600	5,900	7,040	4,890
Antimony	1.4 UJ	1.6 UJ	1.2 U	1.3 UJ	3.3 UJ	1.7 UJ	1.6 UJ	1.4 UJ	1.6 UJ
Arsenic	(81.6)	27.3 J (15.7)	31.5 J+	14.2 J (8.2)	26.7 J	13.3 J (7.6)	41.7 J (24.0)	35.3 J (20.3)	57 J (32.8)
Barium	(1253)	261 J (65.4)	94.2 J+	79.3 J (19.9)	159	123 J (30.8)	424 J (108)	342 J (85.7)	317 J (79.4)
Beryllium	1.4 J+	0.89 J+ (0.69)	1.4 J+	0.75 J+ (0.59)	1.7 UJ	0.87 U	0.78 U	0.68 U	0.82 U
Cadmium	(14.7)	2 J (1.4)	10.4 J (14.7)	0.97 J (0.69)	1.7 UJ	0.87 U	0.83 J (0.59)	1.4 J (1.0)	0.82 U
Calcium	2,560	2,010	1,990	2,050	1,950	1,810	934	1,040	822 U
Chromium	8	5.6	8	6.9	5.1 J	4.7	5.2	5.7	4.8
Cobalt	20.5	12.3 J (9.8)	20.5	11 J (8.8)	18.6	5.4 J (4.3)	3.8 J (3.0)	4.8 J (3.8)	3.6 (2.9)
Copper	1,240 J+	167 J (137)	1,240 J+	201 J 165	216 J	91.4 J (74.9)	42.7 J (35)	98.6 J (80.8)	41.8 (34.3)
Iron	71,200	58,100	71,200	26,000	62,200	44,300	71,700	62,200	88,900
Lead	(2131)	734	1,480 J (2,131)	187	210	366	394	306	541
Magnesium	11,500	4,270	11,500	3,730	2,280	6,090	2,440	3,760	2,180
Manganese	6,750	2,710	6,600	1,160	897 J	1,440	421	580	436
Nickel	15.8	5.2 J (3.9)	11.7 J (15.8)	5.9 J (4.4)	6 J	3.9 J (2.9)	3.1 J (2.5)	3.4 J (2.5)	3.2 J (2.4)
Potassium	1,310 J+	1,260 J+ (72)	642 J+	674 U	1,740 U	865 U	1,300 J+ (74)	1,090 J+ (61)	1,200 J+ (69)
Selenium	(2.6)	0.52 J (0.22)	3 U	0.45 J (0.19)	8.7 UJ	0.51 J (0.21)	1.5 J (0.64)	1 J (0.42)	1.4 J (0.6)
Silver	(2.09)	2.8 J+ (1.6)	1.2 J (2.1)	0.67 U	1.7 UJ	1.2 J+ (0.7)	2.4 J+ (1.4)	1.4 J+ (0.8)	2.1 J+ (1.2)
Sodium	99.3 J+	814 U	600 UJ	674 U	1,740 U	865 U	781 U	676 U	822 U
Thallium	(0.82)	0.81 U	0.44 J- (0.82)	0.67 U	1.7 UJ	0.87 U	0.78 U	0.68 U	0.82 U
Vanadium	52.2	41.1	40.9	36.1	31.3	25.8	40.7	42.3	48.6
Zinc	(2,250)	447 J (298)	1,500 J (2,250)	289 J (161)	339 J-	241 J (161)	197 J (131)	360 J (240)	153 J (102)

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 mg/kg milligrams/kilogram  
 BOLD Background value  
 (X.X) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
 ☆ Concentration elevated 3X background

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TABLE 8, cont.  
 Sediment Sample Results - Total Metals  
 mg/kg (ppm)

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE039 Cement Creek upstream of the confluence with Illinois Gulch drainage and downstream of Ohio Gulch drainage	UASE040 Ohio Gulch drainage (source)	UASE041 Cement Creek upstream of the confluence with Ohio Gulch drainage	UASE042 Cement Creek downstream of the Anglo Saxon Mine drainage	UASE043 Anglo Saxon Mine drainage (source)	UASE044 Cement Creek upstream of the Anglo Saxon Mine and downstream of Minnesota Gulch drainage	UASE045 Minnesota Gulch drainage (1 of 5 backgrounds)	UASE046 Cement Creek upstream of the confluence with Minnesota Gulch drainage
Aluminum	15,700	5,540	5,240	8,220	5,710	5,060	8,860	10,400	5,070
Antimony	1.4 UJ	1.4 UJ	1.3 UJ	1.5 UJ	1.9 UJ	2.5 UJ	1.3 UJ	1.4 UJ	3.8 UJ
Arsenic	(81.6)	34 J (919.5)	54.8 J	34.3 J (19.7)	37.2 J (21.4)	103 J	34 J (19.5)	46.9 J (81.6)	115 J (66.1)
Barium	(1253)	422 J (106)	582 J *	121 J (30.3)	258 J (65)	36.3 J	191 J (48)	314 J (1253)	80.6 J (20)
Beryllium	1.4 J+	0.71 U	0.64 U	0.74 U	0.93 U	10.3 J+	0.66 U	0.96 J+	1.9 U
Cadmium	(14.7)	0.71 U	2.6 J	0.51	0.93 U	4.1 J	2 J (1.4)	0.68 U	1.9 U
Calcium	2,560	735	644 U	1,040	1,040	4,130	2,020	1,350	1,900 U
Chromium	8	5.9	4.5	6.6	8.4	2.5 U	7	7.8	6.2
Cobalt	20.5	3.1 J (2.5)	4 J	5.5 J (4.4)	4.4 J (3.5)	17 J	5.5 J (4.4)	14.8 J (18.5)	2.1 J (1.7)
Copper	1,240 J+	29.8 J ((24.4)	40.4 J	55.2 J (45.2)	59.7 J (48.9)	110 J	76.4 J (62.6)	77.1 J (94.1)	112 J (91.8)
Iron	71,200	56,500	44,400	94,600	123,000	860,000	67,200	37,000	341,000 *
Lead	(2131)	361	598	334	417	255	361	342	1,700
Magnesium	11,500	2,810	2,370	4,550	2,360	1,240 U	5,080	3,850	2,130
Manganese	6,750	311	304	831	636	2,410	804	1,560	540
Nickel	15.8	2.8 J (2.1)	3.3 J	3.9 J (2.9)	3.6 J (2.7)	3.3 J	3.6 J (2.7)	7.5 J (10.1)	2.3 J (1.7)
Potassium	1,310 J+	1,270 J+ (73)	1,230 J+	1,060 J+ (61)	1,410 J+ (81)	1,240 U	933 J+ (53)	1,310 J+	1,900 U
Selenium	(2.6)	1.3 J (0.5)	2 J	0.81 J (0.34)	2.1 J (0.9)	0.21 J	1.1 J (0.5)	1.1 J (2.6)	0.63 J (0.26)
Silver	(2.09)	1.9 J+ (1.1)	3.6 J+ *	1.4 J+ (0.8)	2.2 J+ (1.3)	1.2 U	1.4 J+ (0.6)	1.5 J+	4.1 J+ (1.7)
Sodium	99.3 J+	714 U	644 U	741 U	926 U	1,240 U	657 U	684 U	1,900 U
Thallium	(0.82)	0.71 U	0.64 U	0.74 U	0.99 J+ (0.53)	1.2 U	0.66 U	0.75 J+	1.9 U
Vanadium	52.2	34.6	36.4	49.9	71.7	13.4	45.2	48.6	96.9
Zinc	(2,250)	136 J (91)	604 J	186 J (126)	225 J (150)	2,470 J	478 J (319)	144 J (216)	177 J (118)

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 mg/kg milligram/kilogram  
 BOLD Background value  
 (XX) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
 \* Concentration elevated 3X background

**TABLE 8, cont.**  
**Sediment Sample Results – Total Metals**  
**mg/kg (ppm)**

Sample ID: Location:	Highest Selected Background Value (see Table 7)	UASE047 Cement Creek downstream of the Elk Tunnel and Fairview Gulch	UASE049 Cement Creek upstream of the confluence with Fairview Gulch and the Elk Tunnel discharge and downstream of Georgia Gulch	UASE050 Cement Creek upstream of Georgia Gulch and downstream of the Mammoth Tunnel	UASE054 Prospect Gulch drainage  (source)	UASE056 Cement Creek downstream of the Dry Gulch drainage	UASE058 Cement Creek upstream of the confluence with Dry Gulch drainage
<b>Analytes</b>							
Aluminum	15,700	6,160	7,840	6,640	3,730	6,730	5,750
Antimony	1.4 UJ	1.6 UJ	1.3 UJ	1.6 UJ	1.3 UJ	2.2 UJ	2.7 UJ
Arsenic	(81.6)	24.3 J (14)	37.7 J (21.7)	34.7 J (19.9)	58.9 J	20.3 J (11.7)	35.6 J (20.5)
Barium	(1253)	226 J (56.6)	95.5 J (23.9)	250 J (62.7)	144	142	85.9
Beryllium	1.4 J+	0.78 U	0.64 U	0.81 U	0.63 UJ	1.1 UJ	1.4 UJ
Cadmium	(14.7)	0.78 U	17.5 J (12.4)	2.7 J (1.9)	0.77 J	1.1 UJ	2.7 J (1.9)
Calcium	2,560	867	1,120	1,050	627 U	1,100 U	1,370 U
Chromium	8	6.9	7.9	9.9	4.8 J	6.4 J (5.0)	8 J (6.2)
Cobalt	20.5	2.9 J (2.3)	9.3 J (7.4)	6.4 J (5.1)	4	3.2	4.7
Copper	1,240 J+	47.8 J (39.2)	159 J (130)	60 J (49)	64.9 J	80.7 J (66.1)	212 J (174)
Iron	71,200	57,100	33,000	81,600	53,500	144,000	266,000 ★
Lead	(2131)	304	847	346	254	875	2,050
Magnesium	11,500	2,360	6,800	3,090	2,030	2,820	2,370
Manganese	6,750	407	1,200	1,380	406 J	659 J (531)	1,300 J (1048)
Nickel	15.8	2.8 J (2.1)	7.1 J (5.3)	4.7 J (3.5)	1.9 J	2.9 J (2.1)	2.5 J (1.9)
Potassium	1,310 J+	1,350 J+ (77)	636 U	1,230 J+ (70)	627 U	1,250 J+ (71)	1,370 U
Selenium	(2.6)	2 J (0.8)	0.92 J (0.39)	2	3.1 UJ	5.5 UJ	6.9 UJ
Silver	(2.09)	1.9 J+ (1.1)	2.9 J+ (1.7)	1.7 J+ (1.0)	0.95 J	2.3 J (1.3)	5 J (2.9)
Sodium	99.3 J+	782 U	636 U	813 U	627 U	1,100 U	1,370 U
Thallium	(0.82)	0.8 J+ (0.4)	0.64 U	0.9 J+ (0.5)	0.63 UJ	1.1 UJ	1.4 UJ
Vanadium	52.2	56.3	65.9	72.2	36.5	62	37.2
Zinc	(2,250)	131 J (87)	4,910 J (3273)	693 J (46.2)	192 J	206 J-	628 J (419)

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 mg/kg milligrams/kilogram  
 BOLD Background value  
 (X.X) Corrected Value as per EPA 540-F-94-028 "Using Qualified Data to Document an Observed Release and Observed Contamination".  
 ★ Concentration elevated 3X background

**TABLE 9**  
**Relative Percent Difference (RPD)**

Analyte	UASW005 Surface Water: South Fork of Cement Creek µg/L	UASW098 Duplicate of UASW005 µg/L	RPD	UASE005 Sediment: South Fork of Cement Creek mg/kg	UASE098 Duplicate of UASE005 mg/kg	RPD
Aluminum	720	572	22.9	8,370	5,550	40.5
Antimony	2.5 U	2.5 U	NA	1.3 UJ	1.5 U	NA
Arsenic	2.5 U	2.5 U	NA	11.6 J	11.7 J+	0.9
Barium	25 U	25 U	NA	78.8	190 J+	82.7
Beryllium	0.5 U	0.5 U	NA	0.66 J+	0.76 UJ	14.1
Cadmium	2.73 D	2.41 D	12.5	0.64 UJ	0.76 UJ	17.1
Calcium	162,000	163,000	0.6	1,230	1,500	19.8
Chromium	2.5 U	2.5 U	NA	6.2 J	4.8	25.5
Cobalt	7.71 D	7.36 D	4.6	6.5	4.3	40.7
Copper	8.83 D	6.5 D	30.4	65 J	34.5 J+	61.3
Iron	3,230	3,090	4.4	34,800	30,000	14.8
Lead	0.643 JD	0.5 U	NA	145	72.5 J	66.7
Magnesium	8,230	8,340	1.3	1,460	2,560	54.7
Manganese	1,840	1,860	1.1	839 J	568	38.5
Molybdenum	0.535 JD	0.5 U	NA	—	—	—
Nickel	2.5 U	2.5 U	NA	4.2 J	3.9 J	7.4
Potassium	747 J	752 J	0.7	902 J+	934 J+	3.5
Selenium	2.5 U	2.5 U	NA	3.2 UJ	3.8 U	NA
Silver	0.5 U	0.5 U	NA	0.64 UJ	0.76 UJ	17.1
Sodium	3,470	3,520	1.4	640 U	761 UJ	NA
Thallium	2.5 U	2.5 U	NA	0.64 UJ	0.52	20.7
Vanadium	5 U	5 U	NA	52.2	45.2	14.4
Zinc	647	661	2.1	145 J-	99 J	37.7

**TABLE 9, cont.**  
**Relative Percent Difference (RPD)**

Analyte	UASW019 Surface Water: Mogul Mine Drainage (in wetland) µg/L	UASW099 Duplicate of UASW019 µg/L	RPD	UASE019 Sediment: South Fork of Cement Creek mg/kg	UASE099 Duplicate of UASE019 mg/kg	RPD
Aluminum	10,100	10,200	1.0	5,960	8,140	30.9
Antimony	2.5 U	2.5 U	NA	1.6 UJ	2 UJ	22.2
Arsenic	2.5 U	2.5 U	NA	62.5 J	86.3 J	32.0
Barium	25 U	25 U	NA	121	168	32.5
Beryllium	3.8 D	3.96 D	4.1	0.8 U	1 U	NA
Cadmium	72.8 D	74.2 D	1.9	1.4	1.2	15.4
Calcium	174,000	174,000	0.0	804 U	1,030 U	NA
Chromium	2.5 U	2.5 U	NA	8.5	9.8	14.2
Cobalt	22.6 D	22.6 D	0.0	5.4	6.1	12.2
Copper	820 D	848 D	3.4	177	251	34.6
Iron	4,460	4,570	2.4	116,000	154,000	28.1
Lead	75.6 D	76.6 D	1.3	546 J	656 J	18.3
Magnesium	13,600	13,700	0.7	3,260	4,670	35.6
Manganese	21,900	22,000	0.5	1,130	1,400	21.3
Molybdenum	0.5 U	0.5 U	NA	--	--	--
Nickel	13.6 D	13.7 D	0.7	4.5	4.8	6.5
Potassium	1,420	1,440	1.4	842 J+	1,120 J+	28.3
Selenium	2.5 U	2.5 U	NA	4 UJ	5.1 UJ	24.2
Silver	0.5 U	0.5 U	NA	5.1 J+	7.5 J+	38.1
Sodium	5,520	5,560	0.7	65.3 J+	98.1 J+	40.1
Thallium	2.5 U	2.5 U	NA	0.3 J+	0.31 J+	3.3
Vanadium	5 U	5 U	NA	42.6	44.3	3.9
Zinc	27,600	27,700	0.4	444 J	464 J	4.4

**TABLE 9, cont.**  
**Relative Percent Difference (RPD)**

Analyte	UASW035 Surface Water: Mineral Creek downstream of Kendrick-Gelder Smelter µg/L	UASW097 Duplicate of UASW035 µg/L	RPD	UASE035 Sediment: South Fork of Cement Creek mg/kg	UASE097 Duplicate of UASE035 mg/kg	RPD
Aluminum	7,890	7,870	0.3	5,900	4,750	21.6
Antimony	2.5 U	2.5 U	NA	1.6 UJ	1.6 UJ	0.0
Arsenic	2.5 U	2.5 U	NA	41.7 J	44.2 J	5.8
Barium	25 U	25 U	NA	424 J	443	4.4
Beryllium	1.14 D	1.3 D	13.1	0.78 U	0.79 UJ	NA
Cadmium	6.57 D	6.45 D	1.8	0.83 J	0.79 UJ	4.9
Calcium	177,000	175,000	1.1	934	854	8.9
Chromium	2.5 U	2.5 U	NA	5.2	4.6 J	12.2
Cobalt	22.3 D	21.6 D	3.2	3.8 J	3.5	8.2
Copper	147 D	135 D	8.5	42.7 J	35.8 J	17.6
Iron	12,000	11,700	2.5	71,700	73,000	1.8
Lead	17.4 D	19 D	8.8	394	372	5.7
Magnesium	10,900	10,900	0.0	2,440	1,890	25.4
Manganese	4,580	4,810	4.9	421	344 J	20.1
Molybdenum	0.5 U	0.5 U	NA	--	--	--
Nickel	11 D	9.52 D	14.4	3.1 J	2.7 J	13.8
Potassium	1,840	1,800	2.2	1,300 J+	1,150 J+	12.2
Selenium	2.5 U	2.5 U	NA	1.5 J	4 UJ	90.9
Silver	0.5 U	0.5 U	NA	2.4 J+	2.2 J	8.7
Sodium	4,550	4,580	0.7	781 U	795 U	NA
Thallium	2.5 U	2.5 U	NA	0.78 U	0.79 UJ	NA
Vanadium	5 U	5 U	NA	40.7	37.2	9.0
Zinc	2,340	2,500	6.6	197 J	179 J-	9.6

µg/L micrograms per liter  
 mg/kg milligrams per kilogram  
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 U The analyte was not detected at or above the CRDL.  
 UJ The reported quantitation limit is estimated because Quality Control criteria were not met. Element may not be present the sample.  
 J- The associated numerical value is an estimated quantity but the result may be biased low.  
 J+ The associated numerical value is an estimated quantity but the result may be biased high.  
 D The analyte was identified in a sample at a secondary dilution factor.  
 NA Not applicable